DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-629

TO 31R4-2TRD3-21

DIRECTION FINDER SET AN/TRD-3

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

AUGUST 1957

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 180-volt plate and power supply circuits, or on the 115- and 230-volt ac line connections.

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNIT:

Azimuth Indicator IP–137/GRD . . . . . 2,000-volt circuits

TECHNICAL MANUAL
No. 11-629
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DEPARTMENTS OF THE ARMY AND
THE AIR FORCE

WASHINGTON 25, D. C., *12 August 1957*

DIRECTION FINDER SET AN/TRD-3

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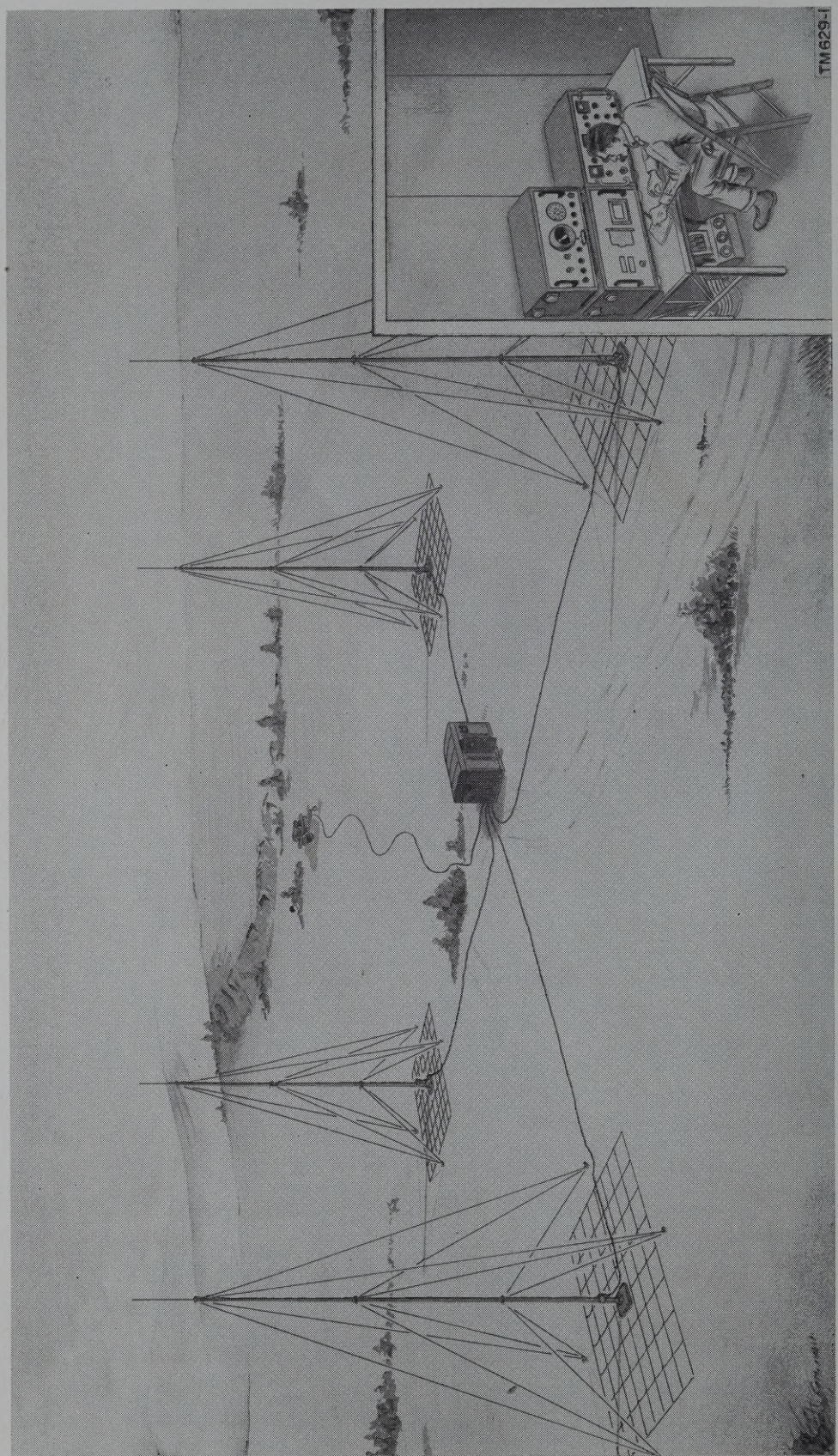

Figure 1. Direction Finder Set AN/TRD-3.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual covers installation, operation, repair, and maintenance of Direction Finder Set AN/TRD–3 (fig. 1).

b. Technical manuals covering detailed operation and maintenance instructions of some of the components of Direction Finder Set AN/TRD–3 are listed below. Those components that are not covered in separate manuals are covered in detail in this manual.

Equipment	Technical manual
Power Unit PU–58/G (Trailer Mounted Gasoline Engine Generator Set PU–236/G).	TM 11–980
Telephones EE–8, EE–8–A, and EE–8–B	TM 11–333
Shelter S–44/G	TM 11–2599
Radio Receiver R–389/URR	TM 11–855

c. Forward comments on this manual directly to Commanding Officer, The United States Army Signal Publications Agency, Fort Monmouth, N. J.

2. Forms and Records

a. Unsatisfactory Equipment Reports. Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700–38.

b. Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58.

c. Preventive Maintenance Forms.

(1) Prepare DA Form 11–238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) in accordance with instructions on the back of the form (fig. 38).

(2) Prepare DA Form 11–239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) in accordance with instructions on the back of the form (fig. 39).

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Direction Finder Set AN/TRD–3 (fig. 1) consists of an assembly of equipments for use in the detection, identification, frequency measurement, and determination of bearing (azimuth) of radio-frequency (RF) transmissions from fixed, mobile, or portable radio sets operating in the frequency range of 100 to 1,500 kilocycles (kc). The direction finder set will give bearings on signals from continuous-wave (cw), amplitude-modulated (AM), radioteletype, facsimile, or other types of RF transmission. (Azimuth bearings of static and jamming signals can also be determined.) When used in conjunction with other direction finder sets, positions of stations, called fixes, can be determined by *triangulation* (fig. 6). Direction Finder Set AN/TRD–3 is designed as a semifixed installation with an easily erected and disassembled antenna system, which will permit a change of site with a minimum of delay. Accessory items furnished with the direction finder set aid in the proper orientation of the antenna system. Two methods of obtaining bearings are the *visual* method and the *aural-null* method.

4. Technical Characteristics

Frequency range:
- Direction finding system..100 to 1,500 kc.
- Radio receiver .....15 to 1,500 kc.
- Target transmitter (used for calibration) .....100 to 2,000 kc.

Antenna system:
- Antenna type .....Crossed Adcock array of vertical monopoles.
- Antenna monopole height..64 ft.
- Array diagonal distance...180 ft.

Types of signals.....Cw, AM, radioteletype, and facsimile.

Bearing presentation:
- Aural-null .....Null on headset or loudspeaker; bearing read from graduated scale.
- Visual .....Display on cathode-ray tube screen; bearing read from graduated scale around screen.

Visual presentations:
- Normal reception without sense applied .....Propeller - shaped pattern (fig. 36).
- Normal sense indication..Arrowhead - shaped pattern (fig. 37).

Instrumental accuracy .....±2°.

Power input .....115 or 230 volts ac, 50- to 60-cps line frequency.

Power consumption .....400 watts.

Total weight, in chests.....3,269 pounds (less power unit).

5. Components of Direction Finder Set AN/TRD–3

a. Components. The components of Direction Finder Set AN/TRD–3 (fig. 2 through 5) are listed in appendix I.

b. Running Spares. A group of running spares is supplied with each Direction Finder Set AN/TRD–3. The list below covers the running spares for all normally expendable items such as tubes, pilot lamps, and fuses.

Quantity	Item
	Direction finder set:
4	Cord, W801 through W804 (125 ft) (CG–1256/TRD–3)
1	Cord, W805 (CG–1257/U)
1	Cord, W806 (CG–1078/U)
1	Cord, W810 (CG–1079/U)
1	Cord, W817 (CX–3331/U)
1	Counterpoise
2	Counterpoise clamps
1	Ground conductor (braid)
1	Antenna coupler
2	Straps, for pipe wrench
1	Gin pole
1	Antenna AS–595/GR (par. 8).
	Azimuth indicator:
1	Cathode-ray tube, 5CP1B
1	Tube type 5R4WGY
1	Tube type 1Z3
1	Tube type 6AS7
1	Tube type 6005/6AQ5W
1	Tube type 5750
1	Tube type 5693
1	Tube type OB2
1	Tube type 5749
4	Crystal diode 1N69
6	Fuse, 1.6 amperes (Bussman No. MDL)
6	Fuse, 1.25 amperes (Bussman No. MDL)
3	Lamp, pilot (Mazda No. 47)
	Radio Transmitter T–339/UR:
2	Tube type 6AK6
1	Tube type 5Y3GT
12	Fuse, cartridge, 1 ampere (Bussman No. MCL)
1	Lamp, neon (GE No. NE–51)
1	Lamp assembly with internal resistor
	Goniometer drive:
1	Lamp, pilot (Mazda No. 47)
	Power Unit PU–58/G:
	Refer to TM 11–980 for list of running spares.
	Sheleter S–44/G:
	Refer to TM 11–2599 for list of running spares.
	Radio Receiver R–389/URR:
	Refer to TM 11–855 for list of running spares.

6. Nomenclature and Common Name

A list of the nomenclature assignments for the components of Direction Finder Set AN/TRD–3 is given below. A common name is indicated after each item.

Nomenclature	Common name
Direction Finder Set AN/TRD–3	Direction finder set
Antenna AS–595/GR (system)	Adcock antenna
Antenna Counterpoise MX–1317/GR	Counterpoise
Antenna Coupler CU–412/TRD–3	Antenna coupler
Gin Pole Derrick MX–1318/GR	Gin pole
Antenna Base AB–398/GR	Antenna base
Azimuth Indicator IP–137/GRD	Azimuth indicator
Electrical Equipment Rack MT–1600/G.	Indicator rack
Goniometer Drive MX–1170/GRD	Goniometer drive
Electrical Goniometer GO–5/GRD	Indicator goniometer
Electrical Goniometer GO–9/TRD–3	Signal goniometer
Electrical Equipment Rack MT–1599/G	Goniometer drive rack
Indicator Case CY–1853/TRD–3	Indicator case
Radio Receiver R–389/URR	Receiver

Nomenclature	Common name
Electrical Equipment Rack MT–1601/UR.	Receiver rack
Receiver Case CY–1852/TRD–3	Receiver case
Radio Transmitter T–339/UR	Target transmitter
Shelter S–44/G	Shelter
Stake GP–2	Stake
Junction Box J–95B/CRD–2	Junction box
Hand Cable Reeling Machine RL–182/G (three supplied).	Coaxial cable reel; spare coaxial cable reel; and power cable reel.
Accessories Case CY–1647/TRD–3	Accessories case
Power Unit PU–58/G	Power unit

7. Description of Equipment

Direction Finder Set AN/TRD–3 consists of a number of major components (pars. 8–14). Certain minor components (par. 15) or accessories are furnished to aid in the operation, alinement, installation, and servicing of the direction finder set. Components which are covered by other technical manuals are listed in paragraph 1*b*.

8. Description of Antenna AS–595/GR
(fig. 2)

a. Antenna System. The antenna system, consisting of four Antennas AS–595/GR, is a crossed Adcock array. Each Antenna AS–595/GR is a monopole and is usually alined to a cardinal point of the compass: north, east, south, or west. A counterpoise, mesh 32 feet square, is provided for each monopole. An antenna coupler is used to provide a connection between each monopole and the RF transmission line to Electrical Goniometer GO–9/TRD–3 (signal goniometer). The diagonal distance of the antenna system is 180 feet, and the total area covered by the system is approximately 16,200 square feet. The shelter is located near the center of the array with a coaxial RF transmission line to each monopole. No separate sense antenna is used.

b. Monopole. Antenna AS–595/GR is a nine-section vertical monopole mounted on an insulated swivel-type antenna base (Antenna Base AB–398/GR) with three sets of guying assemblies and stakes. A canvas container is provided for storing and transporting the disassembled Adcock antenna. The antenna is composed of nine mast sections, the top three of which are Mast Sections MS–116A. The upper end of each mast section, except the four top sections, is inclosed by a press-fitted stainless steel sleeve, 6 inches in length. The lower end of each mast section, except the bottom section and the three top sections, is inclosed by a press-fitted stainless steel slotted sleeve, 12 inches in length. The sleeves provide mechanical, as well as electrical, coupling between the mast sections. Six inches overlap the mast section and the remaining 6 inches extend below. The sleeves are encircled by a heavy vise-type clamp for gripping the top of the mast section immediately below. All mast sections except for Mast Section MS–116A are 9½ feet in length, overall, including the sleeves. The mast sections included in Antenna AS–595/GR, from the bottom section to the top section, are tabulated below—

Mast section	Guying details	Diameter (in.)	Length (ft)
AB–252/GR	None.	3	9½
AB–253/GR	Guy plate with four equidistant guy clamp holes mounted 7 inches below top of mast section.	3	9½
AB–254/GR	None.	2¼	9½
AB–255/GR	Guy plate with four equidistant guy clamp holes mounted 7 inches below top of mast section.	2¼	9½
AB–256/GR	None.	2	9½
AB–257/GR	Guy plate with four equidistant guy clamp holes mounted at top of mast. Plug and socket for Mast Sections MS–116A mounted on top.	2	9
Three MS–116A	None.	⅜	3

9. Description of Electrical Goniometers GO–5/GRD and GO–9/TRD–3

Two electrical goniometers are in the goniometer drive. The signal goniometer (Electrical Goniometer GO–9/TRD–3) samples the RF signal at the antennas, and the indicator goniometer (Electrical Goniometer GO–5/GRD) controls the display of the signal on the azimuth indicator screen. The two

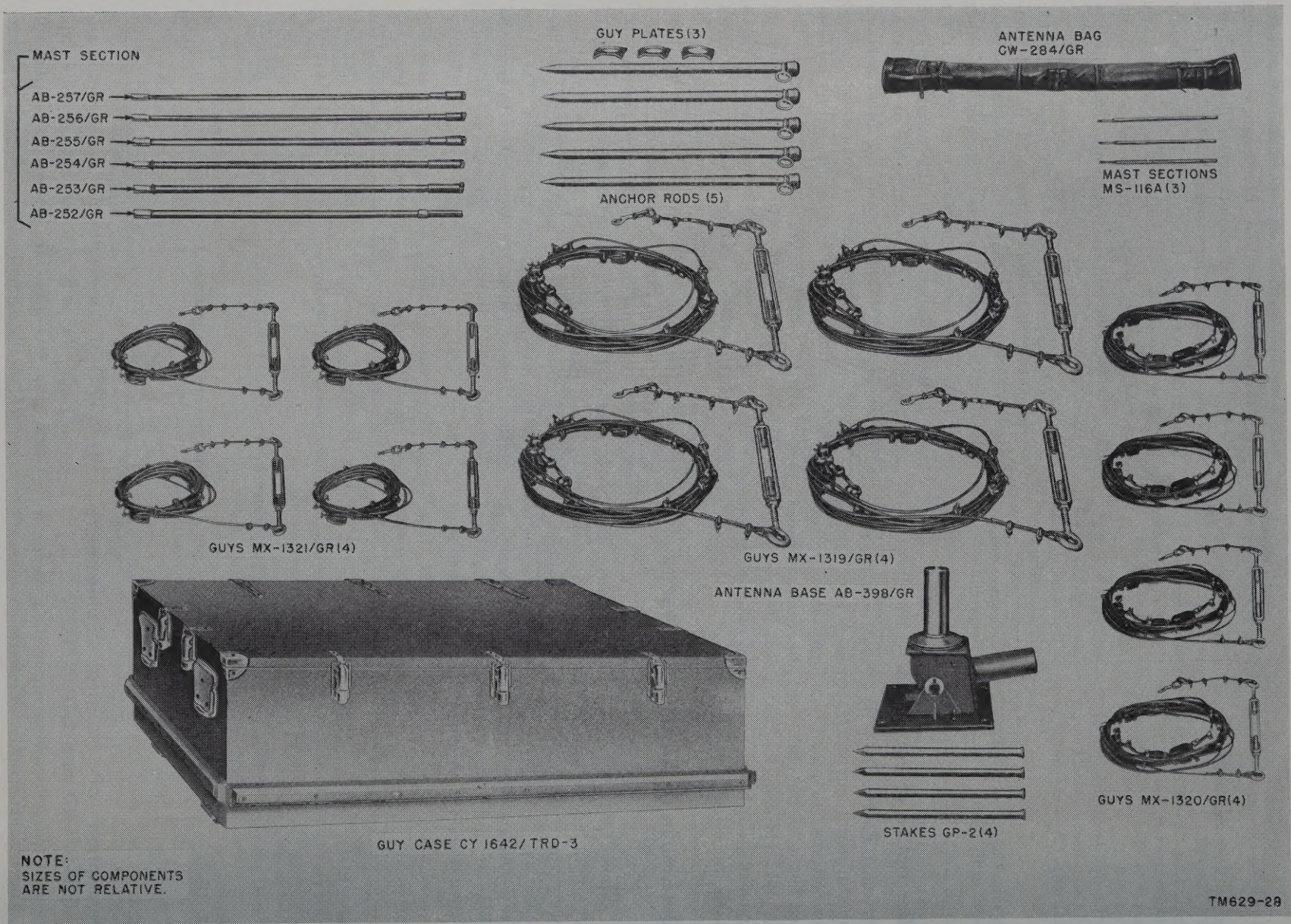

Figure 2. Antenna AS–595/GR, components.

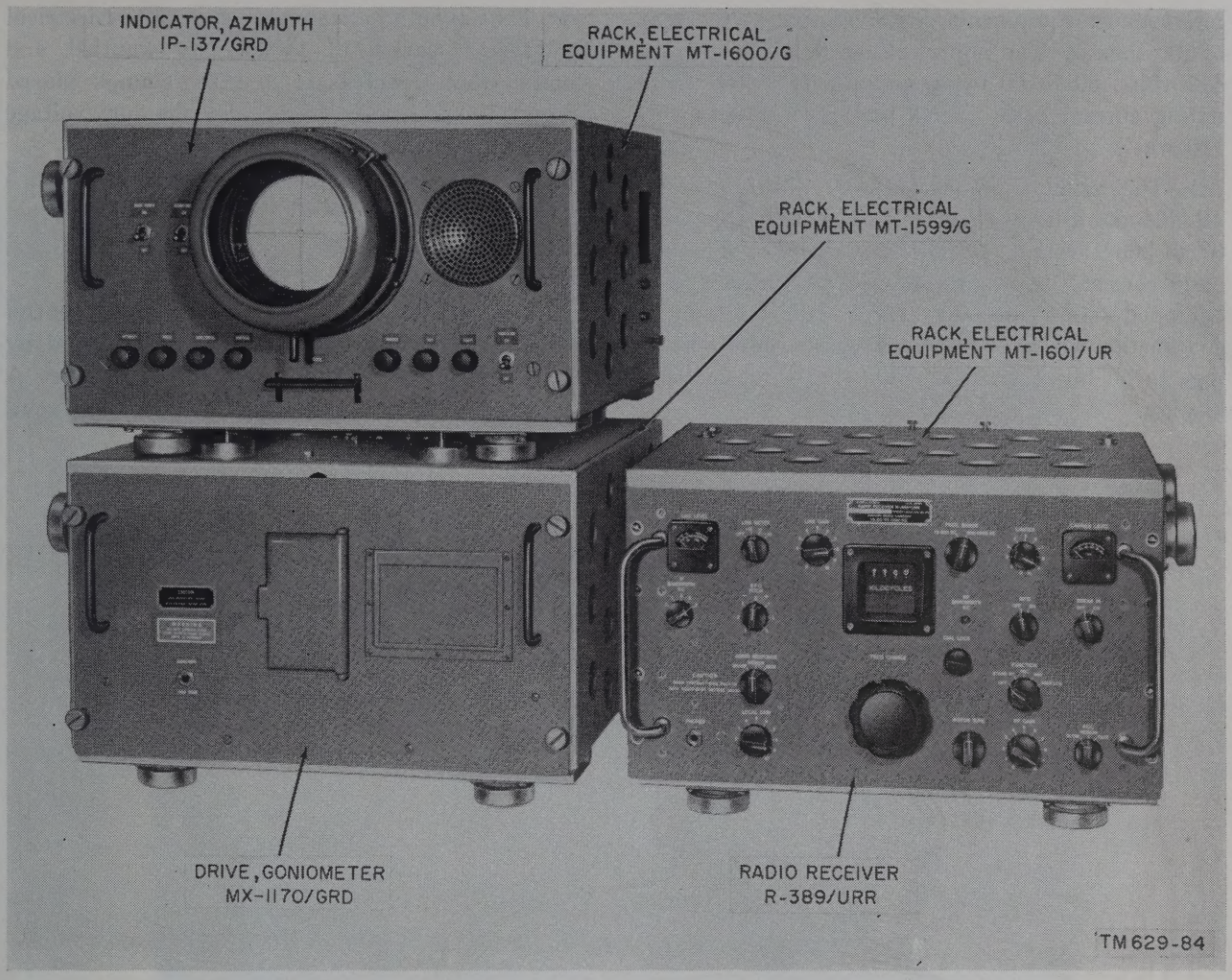

Figure 3. Equipment in racks.

goniometers are similar in physical appearance (fig. 71) and construction. Electrical differences exist, however, to enable the goniometers to perform their individual functions.

10. Description of Goniometer Drive MX–1170/GRD

(fig. 3)

a. The goniometer drive is an assembly for turning the signal and indicator goniometer rotors simultaneously. A scale calibrated in degrees is directly coupled to the rotors which are driven by a 1/15 horsepower (hp) electric motor through a pulley and belt arrangement. The assembly is mounted on a chassis, $12\frac{11}{16}$ inches by 19 inches, with a standard width rack mounting panel which is $10\frac{1}{2}$ inches high. The goniometer drive is housed in a shock-mounted aluminium rack. The goniometer drive rack is equipped with four top-mounted female flanges to provide a base for the indicator rack (fig. 3).

b. The goniometer drive is attached to Electrical Equipment Rack MT–1599/G by knurled and slotted front panel bolts and by clamps placed against the drive frame and the drive motor (fig. 44).

11. Description of Azimuth Indicator IP–137/GRD

a. Azimuth Indicator IP–137/GRD converts information from the goniometer-antenna system into a visual display on a cathode-ray tube. The components of the azimuth indicator are mounted on a chassis, 19 inches wide by 17 inches deep. The front panel of the chassis is a standard width rack panel, $10\frac{1}{2}$ inches high, on which all the controls are mounted. The receptacles and connectors, used to

interconnect equipments, are available at the rear of the chassis. The input voltage requirements are 115 volts, 50 to 60 cycles-per-second (cps) alternating current (ac) with a power consumption of 100 watts.

b. The azimuth indicator is provided with an alidade and a lighted azimuth scale calibrated from 0° to 360° around the cathode-ray tube. The alidade consists of two rotatable cross hairs and is equipped with a sunshade. The alidade assembly in conjunction with the controls enables accurate bearings to be taken from the propeller-shaped visual display.

c. The azimuth indicator is attached to Electrical Equipment Rack MT–1600/G by knurled and slotted front panel bolts and by clamps placed against the indicator frame and the low voltage power supply transformer (fig. 40).

12. Description of Junction Box J–95B/CRD–2

(fig. 4)

Junction Box J–95B/CRD–2 serves as a control and distribution point for the power delivered by the power unit or a commercial power source. A line frequency meter, an output voltmeter, circuit

Figure 4. Junction Box J–95B/CRD–2.

Figure 5. Radio Transmitter T–339/UR.

breakers, and input and output switches are located in two recessed front panels. One 115-volt ac input connector and one 230-volt ac input connector are provided on one side of the box and five output connectors on the opposite side.

13. Description of Radio Receiver R–389/URR

(fig. 3)

a. Radio Receiver R–389/URR provides cw, modulated continuous-wave (mcw), and voice reception over a frequency range of 15 to 1,500 kc. The receiver is housed in an aluminum rack which is provided with shock mounts.

b. Rear connectors and terminals facilitate use of the receiver with the direction finder set components. A 50-ohm intermediate-frequency (IF) output connection is provided for connecting the azimuth indicator. Audio output connectors are provided for the connection of auxiliary speakers and a headset.

c. The receiver is attached to Electrical Equipment Rack MT–1601/UR by slotted machine screws and by clamps placed against the receiver case (fig. 28).

d. For complete information on the receiver, refer to TM 11–855.

14. Radio Transmitter T–339/UR

(fig. 5)

Radio Transmitter T–339/UR is a self-contained battery-powered portable unit for use as a target transmitter (signal source) for the calibration and operational checking of the direction finder set after installation.

a. Physical Characteristics. The target transmitter is housed in a metal case 16¾ inches wide by 14¾ inches high by 12¼ inches deep. The target transmitter weighs 55 pounds with batteries installed. All parts are mounted above or beneath a horizontal chassis, which has covers for shielding the RF coils and other components in the osciliator and amplifier stages. The batteries are mounted in a removable carrier.

b. Antenna. The whip antenna is a five-section vertical antenna composed of three Mast Sections MS–116A, one Mast Section MS–117A, and one Mast Section MS–118A. The assembled antenna mounts in the threaded ferrule socket on the top of the front panel of the target transmitter. When the target transmitter is not in use, the antenna is disassembled and stored in its canvas carrying bag.

c. Power Supply. Three batteries are required for portable operation of the target transmitter; two 90-volt B batteries (Batteries BA–419/U) and one 6-volt A battery (Battery BA–412/U). The batteries are clamped in a removable carrier. Also included in the transmitter case is a power supply that operates from a 115-volt ac power line.

15. Description of Minor Components

The minor components of Direction Finder Set AN/TRD–3 are described below.

a. Counterpoise. The counterpoise (fig. 14) is a 32-foot square of ⅝-inch tinned copper braid. Each of the four antennas has a counterpoise. From the center of the counterpoise, the mesh consists of grids which are 1 foot square for a distance of 2 feet, 2 feet square for a distance of 4 feet, and 4 feet square for a distance of 16 feet. Ground terminals are located on either side of the center of the counterpoise for grounding the antenna coupler box and the mast base. Similar ground terminals are located at each corner of the counterpoise and at the center of each side. The ground conductor is a length of ⅝-inch tinned copper braid with four spade lugs attached to it. Two lugs are used to bond the counterpoise to the mast base, other lugs are for binding the counterpoise to the antenna coupler box.

b. Counterpoise Ground Clamp. The counterpoise ground clamp is used for anchoring the counterpoise to the earth and for an electrical ground. It is a galvanized steel rod, ¼ inch in diameter and 12 inches in length. One end is U-shaped, and has a 3-inch length of ⅝-inch tinned copper braid soldered to it. The braid is terminated with a spade lug for connecting to the ground terminals on the counterpoise.

c. Antenna Coupler CU–412/TRD–3 (fig. 20). The antenna couplers connect each antenna mast to its transmission line. Physically, the antenna coupler consists of a metal box that has an adjustable stainless steel clamp for clamping around the stainless steel sleeve on lower Mast Section AB–252/GR of the antenna. Electrically, the antenna coupler consists of two networks and a selector switch.

d. Gin Pole Derrick MX–1318/GR (figs. 15 and 18). The gin pole is used in raising the masts of the antenna array. The body of the gin pole is made of aluminum tubing 9½ feet in length and 3 inches in diameter. One end of the gin pole fits over the gin pole stub of Antenna Base AB–398/GR and the other end has an assembly which provides for the mechanical attachment of three mast guys and the block and tackle. Refer to the inset of figure 18 for details on the assembly of the guys and block and tackle to the gin pole.

e. Table (figs. 1 and 25). The mounting table supports the electrical equipment racks, housing the goniometer drive, azimuth indicator, and receiver. The top of the table is made of heavy plywood, and is 27 inches high. The top dimensions are 40 inches long by 36 inches deep.

f. Platform (fig. 15). When the antenna masts must be erected on soft ground, the platform is used beneath Antenna Base AB–398/GR of each mast. The platform, made of 1¼-inch plywood, is 3 feet on each side and has four ⅞-inch holes spaced to accommodate Stakes GP–2 when they are driven through the holes of the mast base. A center hole is provided for positioning of the mast locating stake. The platform and mast base are held together and against the ground by Stakes GP–2 when they are driven fully into the ground.

g. Hand Cable Reeling Machine RL–182/G (fig. 21). Hand Cable Reeling Machine RL–182/G consists of a reel mounted in a case. The reel is turned by a crank which fits in a hole on the outside of the case. The reel provides a rapid means of installing the transmission lines and power cable and is also a safe place for storing or shipping the cables. Three reeling machines are provided with the direction finder set.

(1) *Coaxial cable reel.* The coaxial cable reel contains the four transmission lines, color-

coded for the particular monopole with which they will be used. The color coding insures that a matched pair is used with the proper pair of antennas.

(2) *Spare coaxial cable reel.* The spare coaxial cable reel contains two sets of matched pairs of cables for use as spare transmission lines.

(3) *Power cable reel.* The power cable reel contains the 300-foot power cable.

h. Terminal Box. The terminal box is an inclosed metal box that contains the terminals to which the primary power for the shelter is connected. A hinged plate provides access to the interior of the terminal box. The box is 8 inches wide, 7 inches long, and 4 inches high, and mounts on the shelter wall in a convenient position for making all primary connections. Six ⅜-inch screw-type terminals receive the primary power cord and two shelter power cords. The terminals are arranged so that the primary power cords and the shelter power cords are connected in parallel. Refer to the shelter wiring diagram (fig. 31) for electrical details.

i. Compass with Tripod and Accessories (fig. 10). The Adcock antenna system of the direction finder set is oriented accurately by a Leitz type No. 140–LC compass (fig. 10). The compass scale is numbered counterclockwise from 0° to 360°. A rotatable sight with alidade is furnished for alinement of the scale with the marking stakes when laying out the site of the antenna array. A level is part of the compass and insures that the compass pointer is at all times level and not influenced by friction caused by the tilt of the compass case. Provision is included for locking the compass pointer when the compass is stored. The scale is movable so that magnetic declination corrections can be applied to the adjustment of the compass for a particular locality. The tripod is an extendable wooden support that has a maximum height of approximately 58 inches and a minimum height of approximately 37 inches. The mounting for the adapter is 3½ inches in diameter, threaded, with eight threads per inch.

j. Interconnecting Cords and Cables. A number of cords and cables are used in the direction finder set to interconnect the various components. Refer to figures 29 and 31 for the cabling diagram. Paragraph 40 lists the cords and cables and the nomenclature, connection data, and the lengths of the individual cables.

k. Miscellaneous Equipment.

(1) *Block and tackle.* To assist in raising the masts of the Adcock antenna array, the block and tackle (figs. 18 and 19) is used in conjunction with one anchor rod and the gin pole. The block and tackle is of two-block construction, with ½-inch Manila rope.

(2) *Bracket.* A metal bracket for mounting a field telephone is furnished. The bracket may be mounted in a position convenient to the operator of the equipment.

(3) *Chairs.* Two metal folding chairs are provided.

(4) *Sledge hammer.* A 6-pound, double-faced sledge hammer is furnished for driving anchor rods.

(5) *Paint.* Four 1-ounce jars of blue, brown, yellow, and green weatherproof paint are furnished for marking spare cables with the proper color code when they are placed in service. The paint may be used to renew the color code markings on the cables. A brush is attached to the cap of each of the four jars.

(6) *Rod level.* The rod level is a Keuffel and Esser type No. 6299 level. It is a spirit level with an air bubble and a coil spring. The level is clipped to a newly erected antenna to make sure it is exactly vertical.

(7) *Measuring tape.* The steel measuring tape is 100 feet long and ⅜-inch wide. The tape is used when laying out the site for the direction finder set.

(8) *Telephone EE–8–B.* A standard field telephone, Telephone EE–8–B, is furnished. It will provide communication with other direction finder sets that operate as a net, or enable communication with a radio direction finding center. For complete information on the telephone, refer to TM 11–333.

16. Additional Equipment Required

The following equipment is not supplied as part of Direction Finder Set AN/TRD–3 but is needed for use with the set:

a. Shelter S–44/G. The shelter is a knock-down type field and mobile unit used to house the operating personnel and equipment. Refer to TM

11–2599 for complete information on Shelter S–44/G.

b. Power Unit PU–58/G. The power unit is a complete 120- to 240-volt, 60-cycle power plant. It consists of Power Unit PU–58/G mounted on Trailer M–105. Refer to TM 11–980 for complete information on Power Unit PU–58/G.

17. System Application

(fig. 6)

a. One direction finder can determine only the bearing of a distant transmitter. Two or more direction finders must be used to find the position of a transmitter by triangulation. Single direction finders are sometimes used for homing aircraft, but more commonly, direction finders such as the AN/TRD–3 are operated in groups or nets. Bearings from the individual direction finder sets are plotted on maps to establish the position or *fix* of a transmitter. Direction finder nets usually use a minimum of three sets. Figure 6 illustrates the use of three direction finder sets for positioning or fixing of one transmitter.

b. If direction finding could be accomplished without errors, a position fix would always be a definite point. However, because of small unavoidable bearing errors and fluctuations caused by instrumental and propagation factors, a practical position *fix* is an area within which the signal source (transmitter) exists. The two bearing lines drawn toward the source from each direction finder in figure 6 represent the range of possible error or uncertainty in individual bearing.

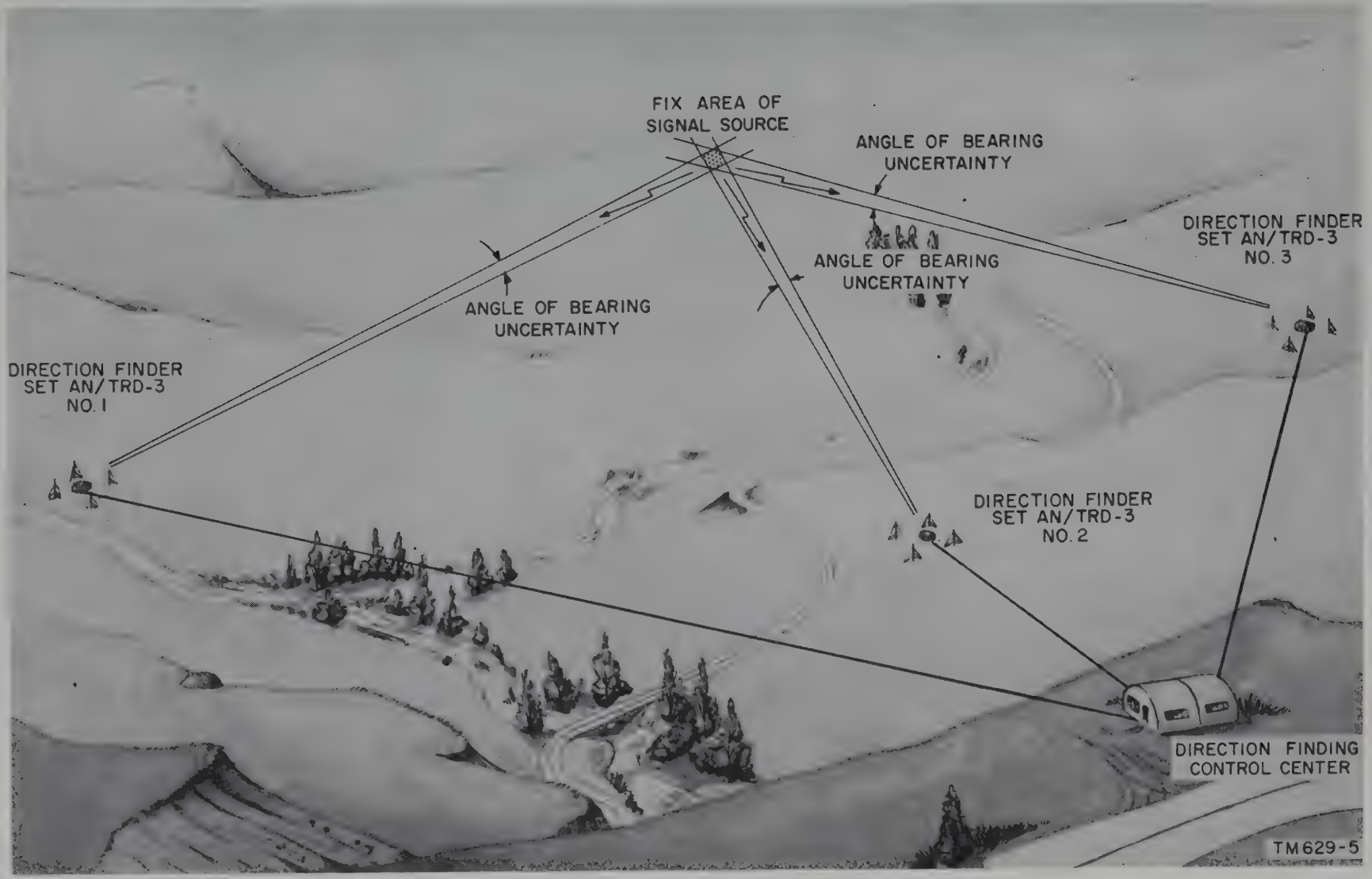

Figure 6. System application.

CHAPTER 2

INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

18. Selection of Site

(fig. 7)

The accuracy of a direction finder depends to a great extent on its location. Ground contour, ground conductivity, obstructions, and nearness to bodies of water will affect the accuracy of the direction finder. Inspect the proposed site in accordance with the following instructions, remembering that all conditions cannot be satisfied and a compromise must be made.

a. The site area should be substantially flat for at least 150 yards from the center of the antenna array with not more than a gentle slope for 1,000 yards. The area should be the highest in the general vicinity. The fact that low areas usually have a higher ground conductivity should be disregarded in the selection of a site for direction finder sets since the advantages of a higher site are greater than the advantages of greater ground conductivity.

b. Mountainous country or terrain with abrupt changes in elevation should be avoided. A site that is near a cliff or deep ravine should not be used.

c. Avoid large bodies of water. Locate the direction finder sets as far inland as possible. If it is necessary to locate it near the coast, select the flattest site and locate the antenna system so that signals from the target area cross the coast line at right angles.

d. The earth surrounding the antenna site should have uniformly high conductivity and moisture content. Uniformity of conductivity is the important factor. Areas uniformly covered with vegetation usually meet this requirement. Rocky or a sandy soil has low conductivity and should be avoided when possible.

e. Do not locate the direction finder set near tall trees, buildings, wire fences, power or telephone lines, radio antennas, railroad tracks, buried conductors (underground pipelines or cables), chimney stacks, rivers, lakes, streams, and main highways. Refer to the following table for common obstructions and minimum distances.

Obstruction	Minimum distance to be maintained
Scattered trees; single small buildings	300 yards
Wire fences	300 yards
High cliffs; deep ravines	More than 1 mile
Buried metallic conductors (other than lines to Direction Finder Set AN/TRD–3).	300 yards
Chimney stacks; water towers	500 yards
Overhead conductors and railroad tracks	500 yards
Rivers, streams, and lakes	600 yards
Forest and metal structures	500 to 1,000 yards
Mountains	5 to 25 miles

19. Preparation of Site

a. Location of Antenna System. Clear off an area of level ground about 240 feet square for placement of the antenna system. Additional leveling of the ground at the exact locations of each mast might be necessary so that the platforms will be level.

b. Location of Shelter S–44/G. Locate the shelter near the center of the antenna system. Be sure that the anchor rod of each antenna (north, south, east, and west) is visible from the center stake (fig. 7). Clear a level area for the shelter approximately 25 feet square.

c. Location of Power Unit. Power Unit PU–58/G or equivalent is to be used when commercial power is not available. Locate the power unit 250 feet north of the shelter. If possible, bury the power cable. The area selected should be cleared and leveled as much as possible.

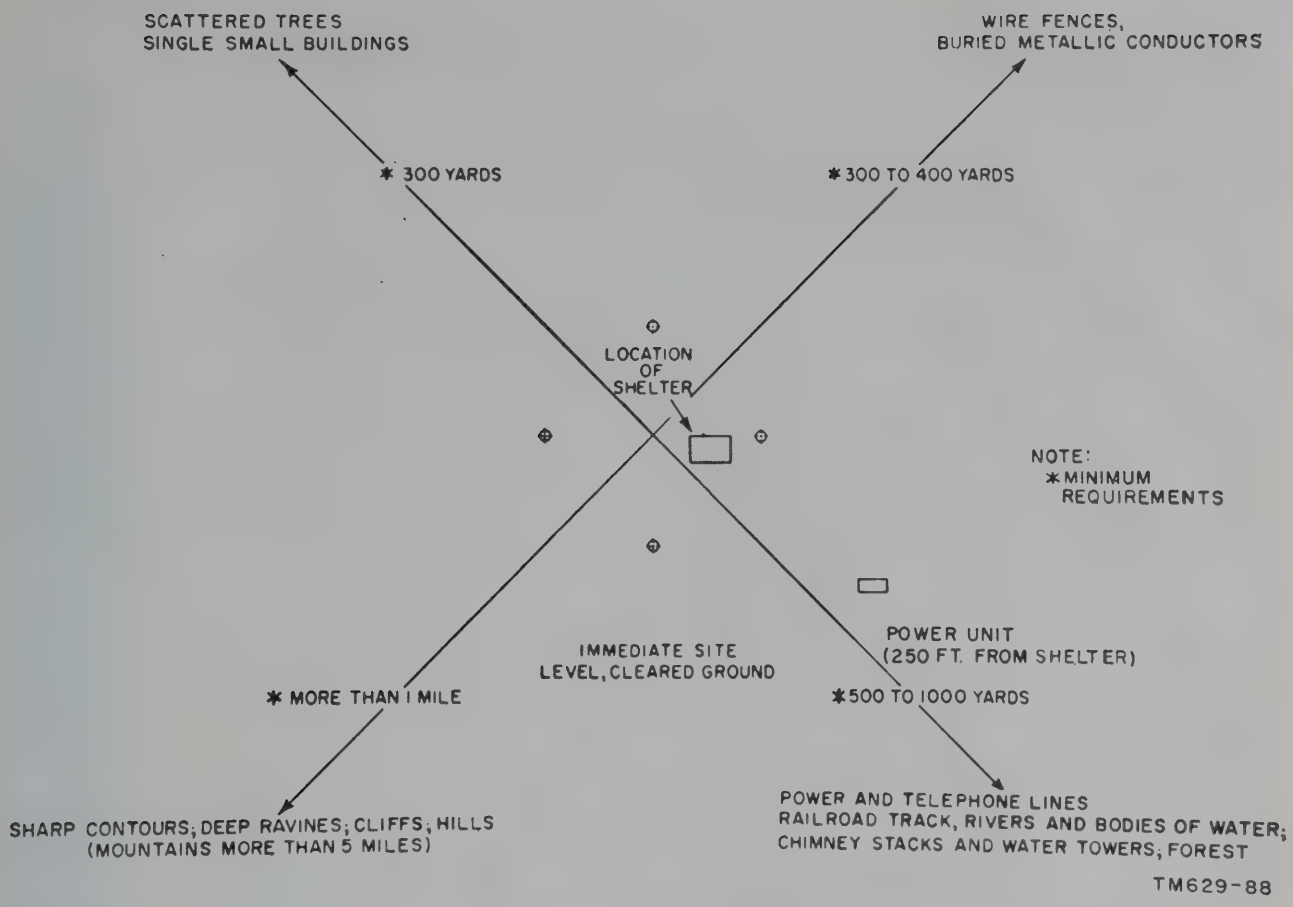

Figure 7. Selection of site.

20. Unpacking

a. Packaging Data. The components of Direction Finder Set AN/TRD–3 are stored in cases (figs. 9, 21, 22, and 23) except for parts of the antenna system which are stored in special canvas bags (fig. 12). When packaged for oversea shipment, each case and canvas bag is individually wrapped in moisture-vaporproof barrier paper and sealed with pressure-sensitive tape. The wrapped cases and bags are then placed in individual wooden boxes. A typical shipping box and its contents are shown in figure 8. Seventeen wooden boxes are required to package Direction Finder Set AN/TRD–3. The chart in appendix II itemizes the contents of each wooden box.

b. Removing Contents. The procedures listed below are typical for all of the packing cases.

(1) Place the packing case as near the operating position as convenient.

(2) Cut and fold back the steel straps.

(3) Remove the nails from the top and one side of the box with a nail puller. Remove the top and one side. Do not attempt to pry off the sides and top.

(4) Remove the wrapped case or canvas bag from the wooden box.

(5) Remove the barrier paper from the case or canvas bag. Open the case or canvas bag and check its contents.

21. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, refer to paragraph 2.

b. See that the equipment is complete as listed on the packing slip. If a packing slip is not available, check the equipment against the table of components in appendix I.

c. If the equipment has been used or reconditioned, see whether it has been changed by a Modi-

fication Work Order (MWO). If modified, the MWO number will appear on the front panel near the nomenclature plate. Check to see that this MWO number also appears on the schematic diagram of the manual accompanying the equipment. If not, add a note to the schematic diagram.

22. Special Tools and Equipment Required for Installation

Tools and test equipment required for installation of the direction finder set are packed in Accessories Case CY–1657/TRD–3 (fig. 9). The target transmitter (fig. 5) is used to check the calibration

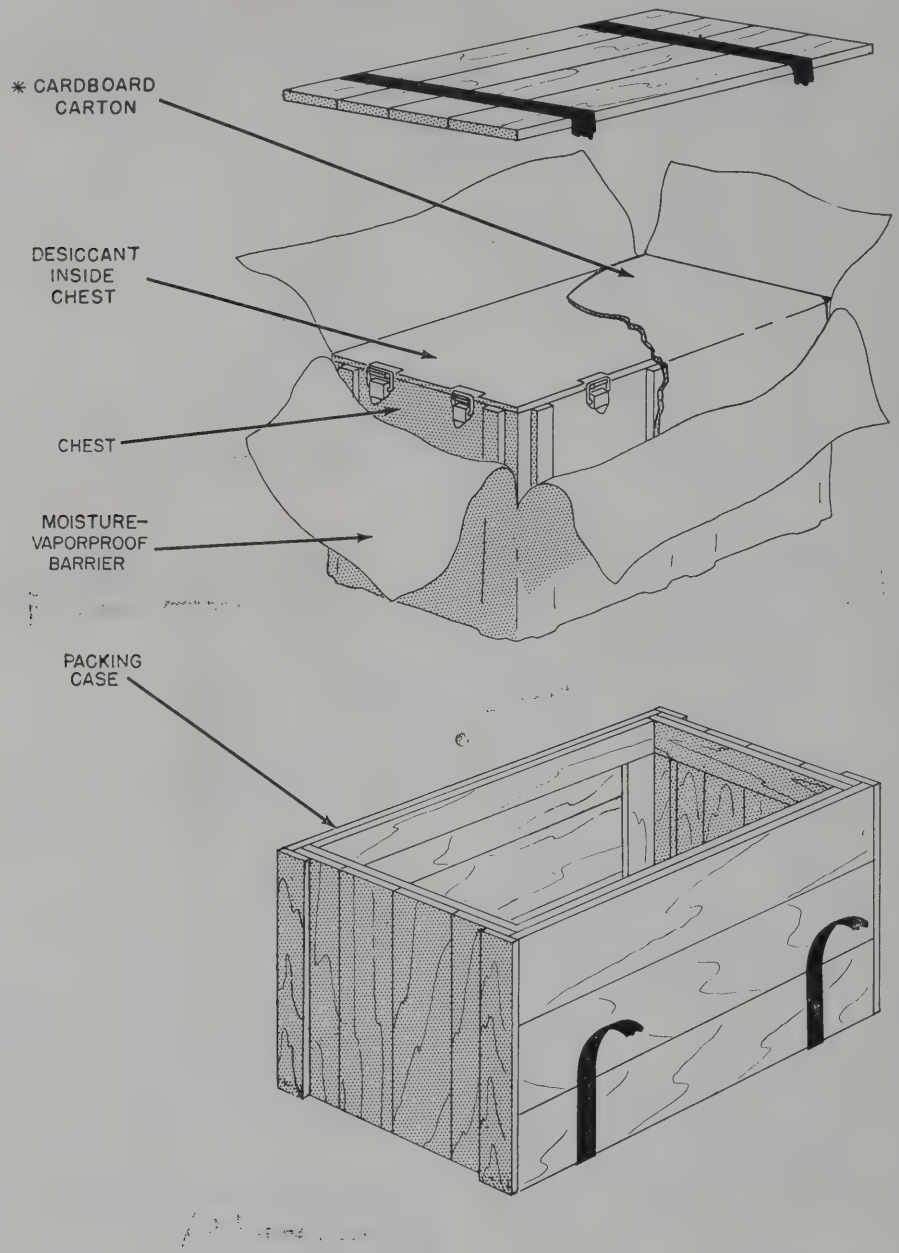

Figure 8. Typical packaging for Direction Finder Set AN/TRD–3.

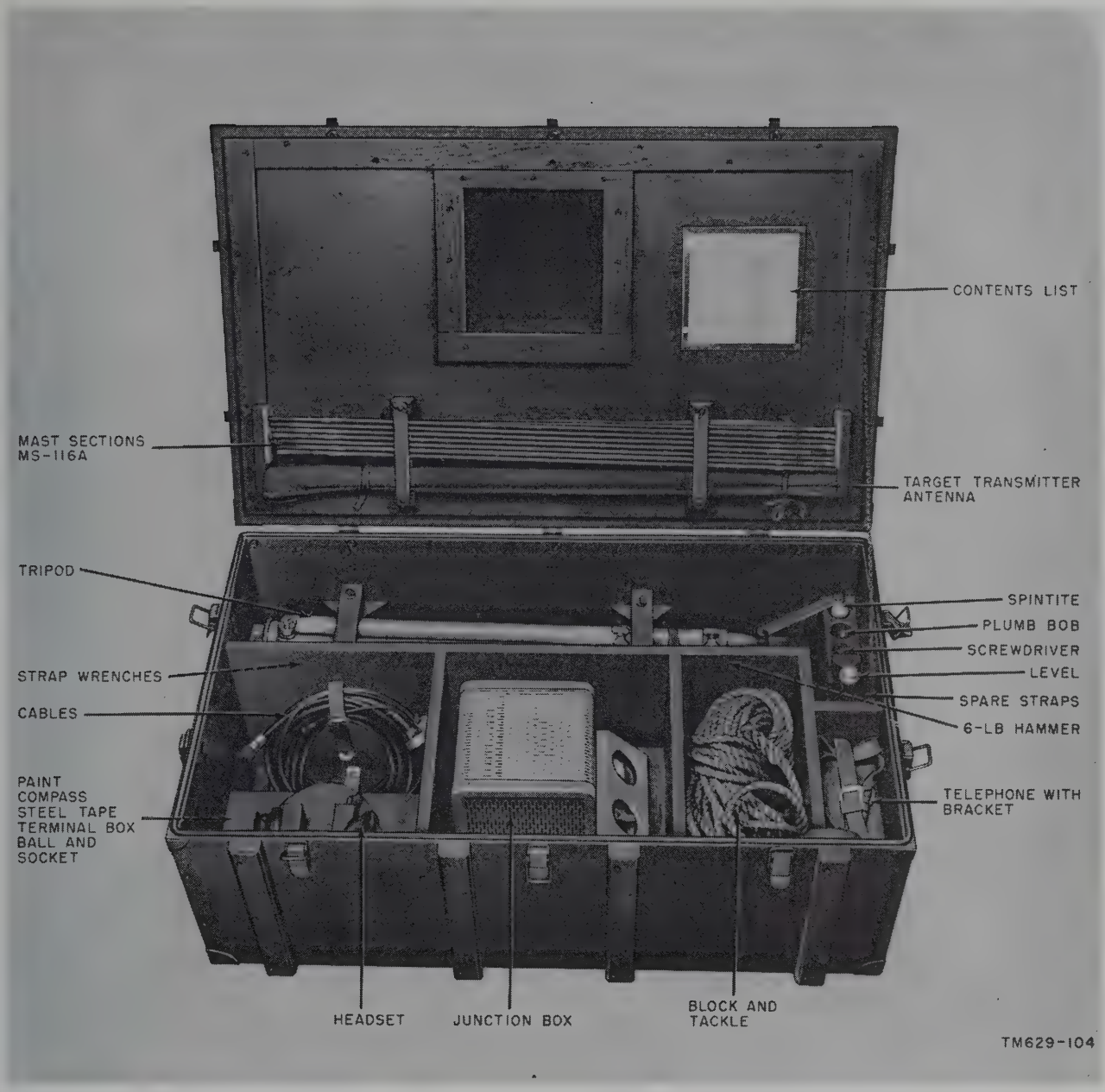

Figure 9. Accessories Case CY–1647/TRD–3.

of the direction finder set and is packed in Case CY–1644/TRD–3.

23. General Installation Instructions

After selection and preparation of the site (pars. 18 and 19), and unpacking and checking of the equipment, installation can be started. For efficient installation, follow a step-by-step method. The main steps of the installation procedure are listed below and are discussed in detail in paragraphs 24 through 44.

a. Tools, materials, and components are positioned for convenient use during erection and installation.

b. The antenna system is oriented and staked out.

c. The shelter is assembled near the center of the site.

d. The platform counterpoise and mast base are placed at the staked positions for each antenna monopole.

e. One antenna and guy assembly is placed at each antenna monopole position.

f. Each counterpoise is secured in position and each antenna mast and guy system is assembled.

g. The masts are erected, beginning with the north antenna and following with the east, south, and west antennas in that order; use the gin pole and block and tackle.

h. The antenna masts are straightened and then secured.

i. An antenna coupler is installed on each erected mast.

j. Shelter-housed equipments are installed in the shelter and interconnected. If sufficient personnel are available, install equipment in the shelter immediately after the shelter is assembled.

k. The power unit is positioned and connected to the shelter terminal box.

l. The four transmission lines are installed; connections are made at each antenna coupler and to the proper connectors in the shelter.

24. Preinstallation Instructions

a. Place the boxes containing Shelter S–44/G, and the equipment to be installed within the shelter, at a convenient location near, but not on, the center of the site. Make the preparations listed below before starting the installation.

(1) Locate the approximate center of the site. The shelter will be located near this point.

(2) The north, south, east, and west antennas are located 90 feet from the center of the site. Use the compass and 100-foot steel rule to locate the proper place for the assembly of each antenna. Place the components for an antenna mast at each position.

(3) Place the following components at each mast location as determined in (2) above:

5 rod anchors
4 Stakes GP–2
1 platform
1 Antenna Base AB–398/GR
4 Guys MX–1319/GR (61 ft 10 in.)
4 Guys MX–1320/GR (46 ft 11 in.)
4 Guys MX–1321/GR (35 ft 0 in.)
1 Antenna Counterpoise MX–1317/GR
8 counterpoise clamps
1 Mast Section AB–252/GR
1 Mast Section AB–253/GR
1 Mast Section AB–254/GR
1 Mast Section AB–255/GR
1 Mast Section AB–256/GR
1 Mast Section AB–257/GR
3 Mast Sections MS–116A
3 guy plates
1 ground conductor

(4) Place Gin Pole Derrick MX–1318/GR and block and tackle, used for erecting each mast, near the north mast location (the north mast to be erected first).

b. Proceed with the assembly of the shelter (par. 26).

25. Orientation of Antenna System

The antenna system must be accurately oriented with respect to either true north or magnetic north, as directed. Determination of latitude and longitude of the antenna site is helpful but not necessary if the direction finder set is to be used with grid coordinate maps. The following materials are required for orientation of the antenna system:

Item	Quantity
Compass	1
Tripod	1
Adapter	1
Plumb line with bob	1
Stake GP–2	5
Steel measuring tape	1

a. Compass Placement. The first step in antenna system orientation is the assembly and placement of the compass at the center of the proposed antenna site. Proceed as follows:

(1) Drive Stake GP–2 into the center of the antenna site as selected in paragraph 19, so that approximately 2 inches of the stake remain exposed above ground.

(2) Assemble the tripod (fig. 10). Install the plumb line and adjust it so that the center of the tripod is directly above the center of Stake GP–2.

(3) Install the adapter onto the tripod.

(4) Carefully remove the carrying case that contains the compass from the chest in which it is packed.

(5) Install the compass on the tripod (fig. 10).

(6) Level the compass until the air bubbles in the spirit levels appear in the center of the alinement scratch marks on the tubes.

b. Compass Adjustment. Procedure for adjusting the compass with relation to either magnetic north or true north is given in (1) through (3) below.

(1) *Scale adjustment.* Adjust the compass scale so that the index points to the 0° mark.

(2) *Magnetic north.* Release the compass needle by turning the screw on the bottom plate of the compass. When the needle stops swinging, rotate the compass until the north end of the needle and the 0° to 360° mark coincide. The viewing sights then point to magnetic north.

(3) *True north.* By referring to a suitable map, determine the magnetic declination for the locality in which the set is to be used. Check the date of the map; the latest declination data should be used. Rotate the compass under the freed needle in the direction which will compensate for the magnetic declination.

(*a*) To compensate for a magnetic declination of 12° *west,* rotate the compass scale so that the index points to the 348° mark on the compass. The sights will then point to true north, while the needle points to the magnetic north.

(*b*) To compensate for a magnetic declination of 12° *east,* rotate the compass scale so that the index points to the 12° mark on the compass. The sights will then point to true north, while the needle points to magnetic north.

Note. Magnetic declination may be defined as an angle between true north and the direction indicated by a magnetic compass. This angle varies greatly from place to place and from year to year. It is necessary to use charts or maps of recent date which show the declination and the annual changes in declination.

c. Mast Base Stake Alinement. With the compass adjusted to point to either true or magnetic north, drive a marker stake (Stake GP–2) into the ground in line with the sights of the compass and at a distance of exactly 90 feet (measured with the steel tape) from the center marker stake (fig. 11). This is the north marker stake. Rotate the compass exactly 180° and drive a south marker stake into the ground at a distance of 90 feet from the center stake. Check the compass level, the compass orientation, and the stake alinement when viewed through the compass sights. Rotate the compass to the 90° mark and drive an east marker stake into the ground at a distance of 90 feet from the center stake. Rotate the compass exactly 180° from the east position (to the 270° mark on the compass scale) and drive the west marker stake at a distance of 90 feet from the center stake. Recheck the compass level, the compass orientation, and the stake alinements. After the stakes are alined, set aside the compass, tripod, and other accessories. Drive the stakes into the ground until about 1 inch of each stake is visible above ground.

26. Installation of Shelter S–44/G

The shelter must be unpacked as described in TM 11–2599. The shelter is shipped disassembled and crated in four crates. Crate No. 1 contains the floor section, the roof section (with blower and wiring assemblies) and all side wall panels except the one on which the heater assembly is mounted. The heater assembly and panel and the fuel tank are packed in crate No. 2. Hand tools, ladder, fire extinguisher, joining cover, blackout curtains, skid rope, and manuals are contained in crate No. 3. Crate No. 4 contains the loading skids. Before unpacking, locate the crates that contain the shelter components near the center of the proposed site. Open the crate that contains the manual (crate No. 3) first. Open the others as their contents are needed.

27. Platform Installation

If the earth at the antenna site is very soft and poor footing exists, install a platform as a base for each monopole. Refer to figure 15 for a cross sectional illustration of the mast base platform and the earth. To install the platform, proceed as follows:

a. Check to see that the earth at the marker stake is as level as possible, and that there no rocks, pebbles, or other obstructions around the marker stake.

b. Place the hole in the center of the platform over the marker stake. The stake need not be removed.

c. Aline the platform so that its sides are north and south, east and west.

28. Counterpoise Installation

a. Antenna Counterpoise MX–1317/GR is a 32-foot square mesh of tinned copper braid (figs. 12 and 14) used with each monopole of the Adcock antenna array. Four identical counterpoises are used and are installed after installing the platforms.

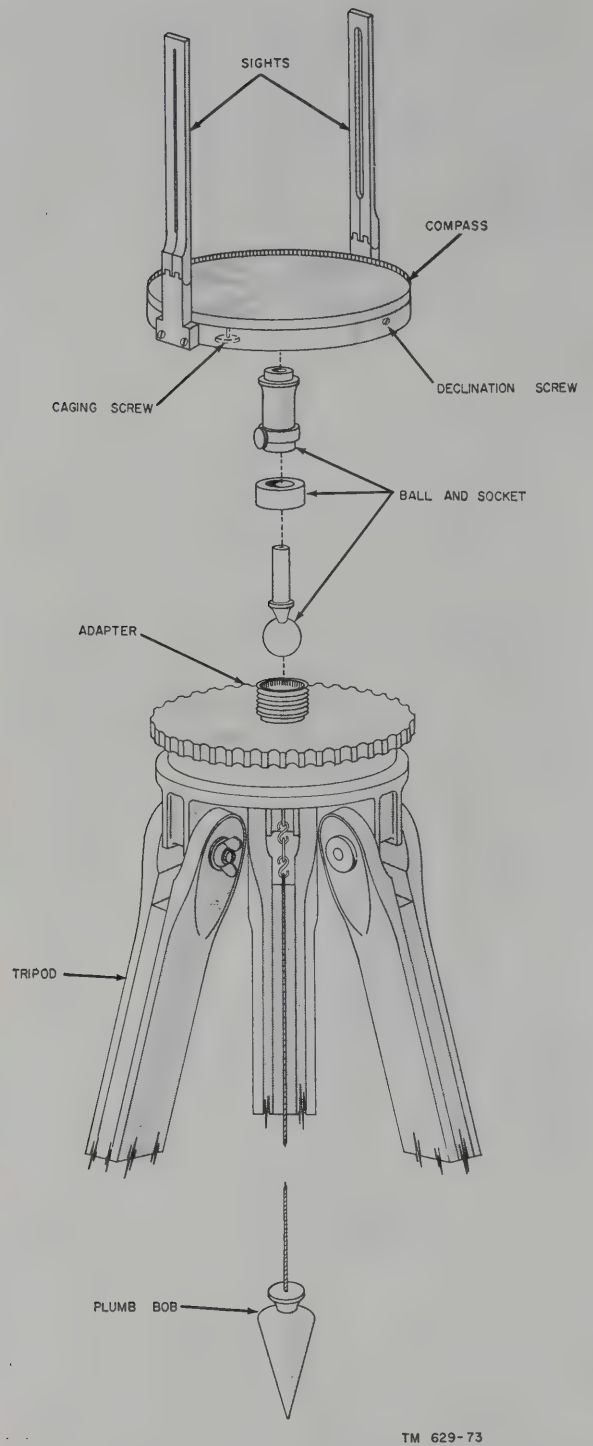

Figure 10. Compass and tripod assembly.

b. To install the counterpoise, proceed as follows:

(1) Unroll and unfold the canvas bag to expose the counterpoise (fig. 12).

(2) Locate the center of the counterpoise (point 1) over the mast base platform center (fig. 13).

(3) Loosen ties 6 through 10; be sure to untie the top knots only.

(4) Loosen ties 2, 3, and 4; be sure to untie the top knots only.

(5) Station men at tie points 1, 3, and 5.

(6) Loosen tie points 1 and 5; be sure to untie the top knots only.

(7) Unfold the loosened portion of the counterpoise.

(8) Place the ground clamps at points A and B to hold the counterpoise for the next unfolding procedure.

(9) Loosen ties 6 through 15; be sure to untie the top knots only.

(10) Repeat the steps in (4) through (7) above.

(11) Place the ground clamps at points C and D.

(12) Loosen all the ties except 5 and 15; be sure to untie the top knots only.

(13) Station men at points B, D, and K.

(14) Loosen ties 5 and 15; be sure to untie the top knots only.

(15) Unfold the loosened portion of the counterpoise. Permanently attach the ground clamps at points C, D, E, and F. Remove the ground clamps at points A and B.

(16) Loosen all the remaining ties and remove the bag. Fold or roll up the bag and store for future use.

(17) Unfold the counterpoise to its final position.

(18) Install the balance of the ground clamps as shown at points C through K (fig. 14).

c. To repack the counterpoise, reverse the above steps.

29. Installing Antenna Base
(figs. 15 and 20)

When the counterpoise installations are completed, install Antenna Base AB–398/GR. Figure 15 shows the relationship (in cross section) of the earth, platform, and the antenna base. Four Stakes GP–2 are used to anchor the antenna base plate to the platform and to the earth. Directions given below are for the installation of the north antenna base; the remaining three (east, south, and west) are installed in an identical manner.

a. Carefully center the four holes in the antenna base plate over the four corresponding holes in the

NOTES:

1. PRIOR TO LAYING OUT SITE, CLEAR OFF AND LEVEL GROUND FOR A RADIUS OF 125 FEET FROM PROPOSED CENTER OF ANTENNA SYSTEM.
2. USE COMPASS WITH TRIPOD AND PLUMB LINE FOR DETERMINATION OF CARDINAL POINTS WITH RESPECT TO SITE CENTER.
3. CAREFULLY MEASURE 90 FEET IN NORTH, EAST, SOUTH AND WEST DIRECTIONS AND DRIVE WOODEN MARKER STAKES FOR LOCATING THE INDIVIDUAL ANTENNA MASTS.
4. FOR LAYING OUT INDIVIDUAL MONOPOLE SITES, REFER TO INSET.
5. NORTH MAY BE TRUE OR MAGNETIC, DEPENDING UPON TACTICAL ORDERS

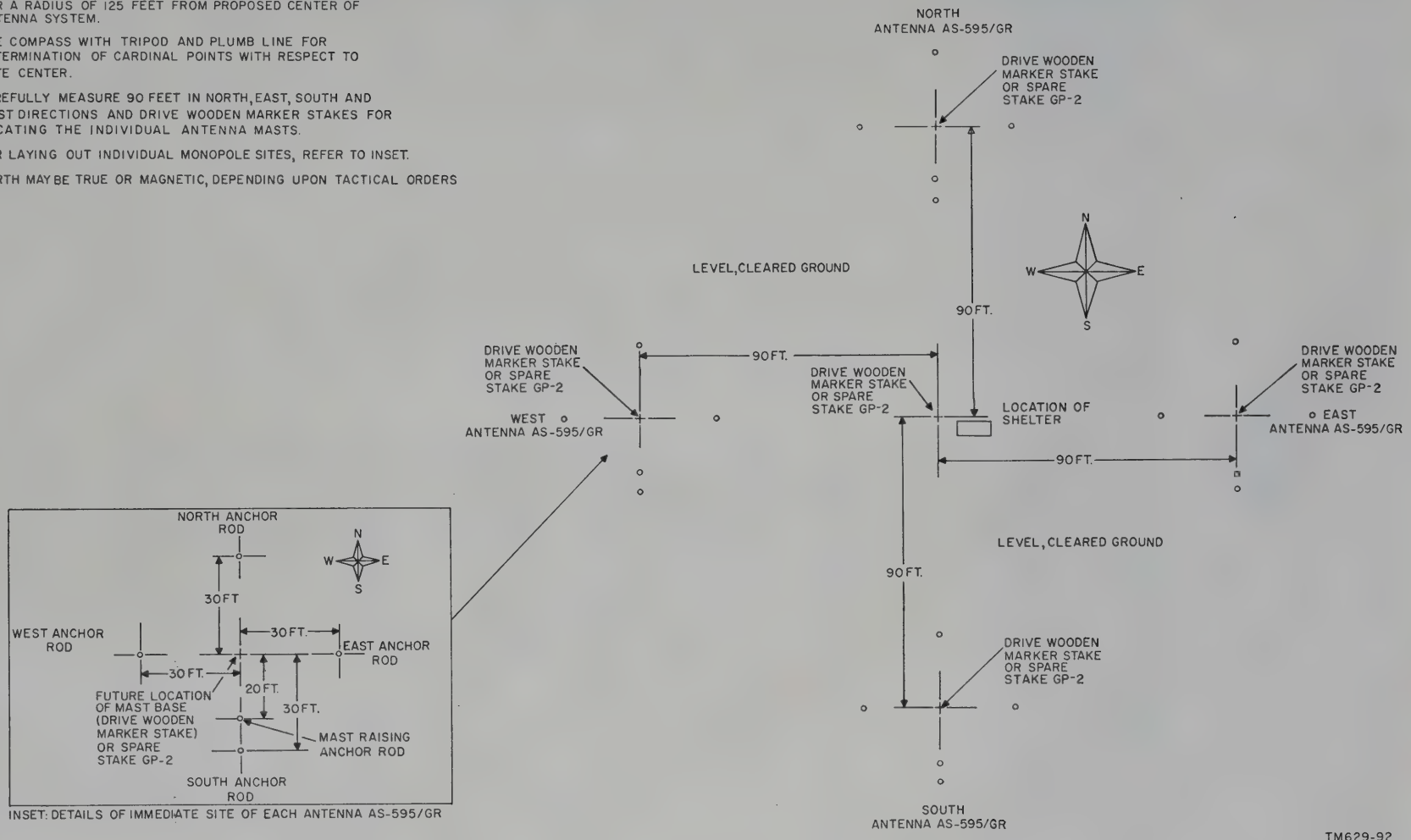

Figure 11. Laying out site.

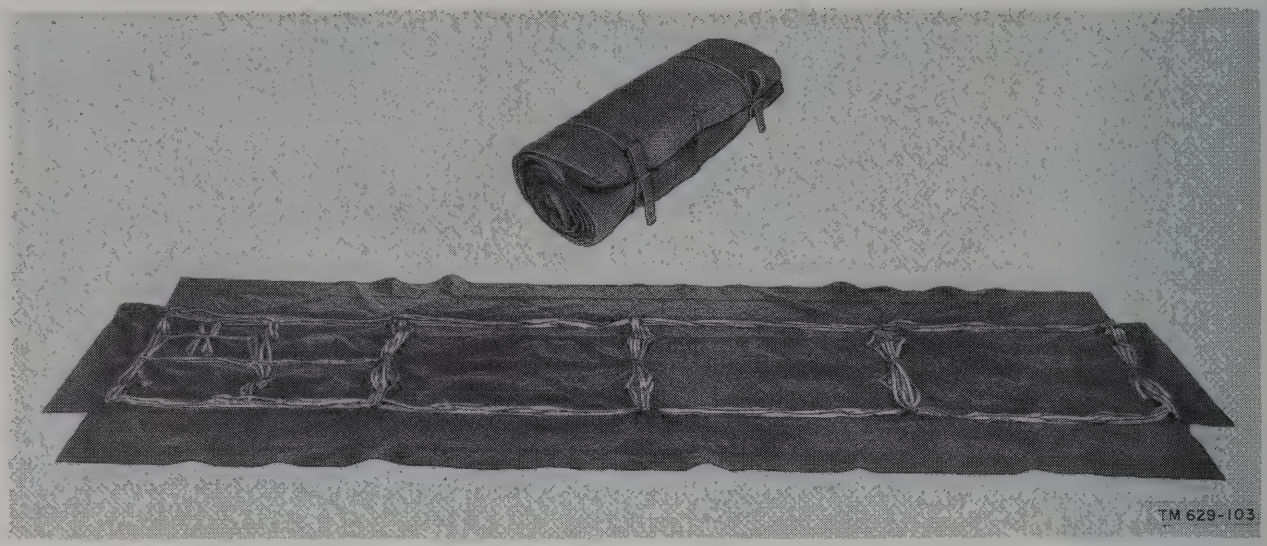

Figure 12. Bag for Antenna Counterpoise MX–1317/GR.

platform, and position the antenna base so that the stub for holding the mast section is pointing toward the north.

b. Remove all kinks and bends in the counterpoise between the antenna base plate and platforms.

c. Drive Stake GP–2 in each of the four holes. Drive each stake in turn to half of its full length, then if the centering is correct, drive them to their full length to firmly anchor the base plate to the platform. Use the 6-pound sledge hammer for driving the stakes.

d. Connect the ground conductor as shown in figure 20. Ground connections are made to the wingnuts on the antenna base, and to counterpoise grounding terminals.

30. Placing Guy Stakes and Raising Stake
(figs. 11 and 17)

One anchor rod (or two if soft ground conditions exist) is used to anchor the block and tackle when raising the monopole. The mast-raising anchor rods are used only during erection of the mast and may be removed immediately afterward. The north, south, east and west anchor rods remain in the ground and provide a permanent anchoring point for the mast guys. The positions of the anchor rods for a mast are shown in figure 11.

a. At points 30 feet north, east, south, and west of each monopole, drive the anchor rods into the ground. Leave only enough of the anchor rods above the ground to allow free movement of the guy ring assemblies. When driving the anchor rods, allow the points to travel inwardly toward the mast so that the anchor rods will project away from the mast at an angle of 30°. This will help prevent high winds from uprooting the anchor rods.

b. Measure 20 feet south (the direction of the gin pole stub) of each monopole, and drive, at an angle of 30°, mast-raising anchor rod with its guy ring assembly installed. The mast-raising anchor rods will be located between each antenna base and the south anchor rod, and will be used for attaching the lower end of the block and tackle assembly. Leave a few inches of the mast-raising anchor rods projecting above the ground so that the guy ring assembly will have freedom of movement.

31. Assembly of Antenna Masts
(figs. 16 and 17)

The north antenna mast will be assembled first, followed by the east, south, and west antenna masts.

Caution: Before fitting mast sections together, make sure that the contacting surfaces are clean. Dirty, corroded, or greasy contacting surfaces cause poor performance and unbalance in the direction finding system.

a. Position the mast section stub of the mast base assembly to point toward the north anchor rod. The gin pole stub then will be in a vertical position (fig. 15).

b. Place Mast Section AB–252/GR over the stub pointing toward the north anchor rod. Slide it fully

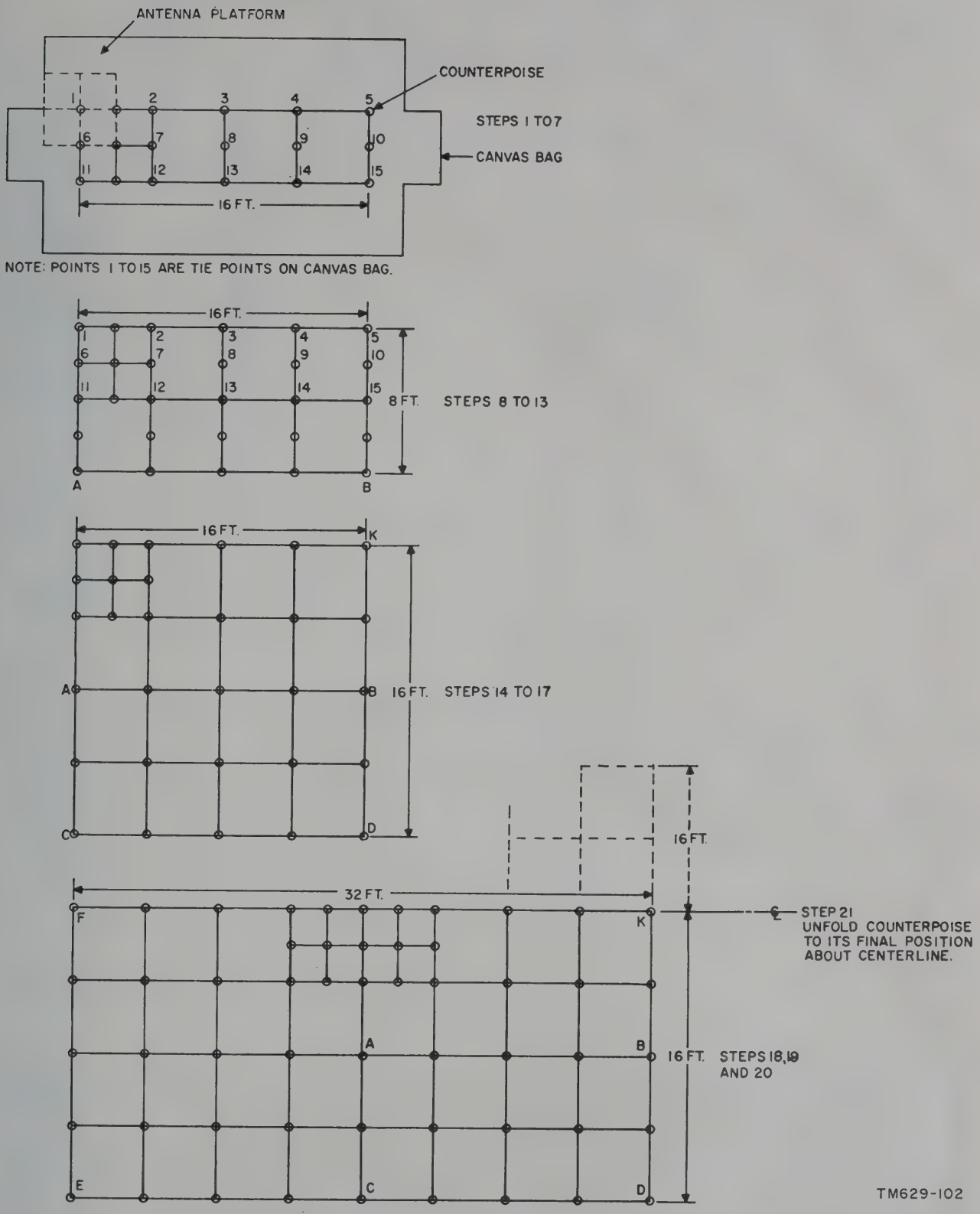

Figure 13. Counterpoise installation steps.

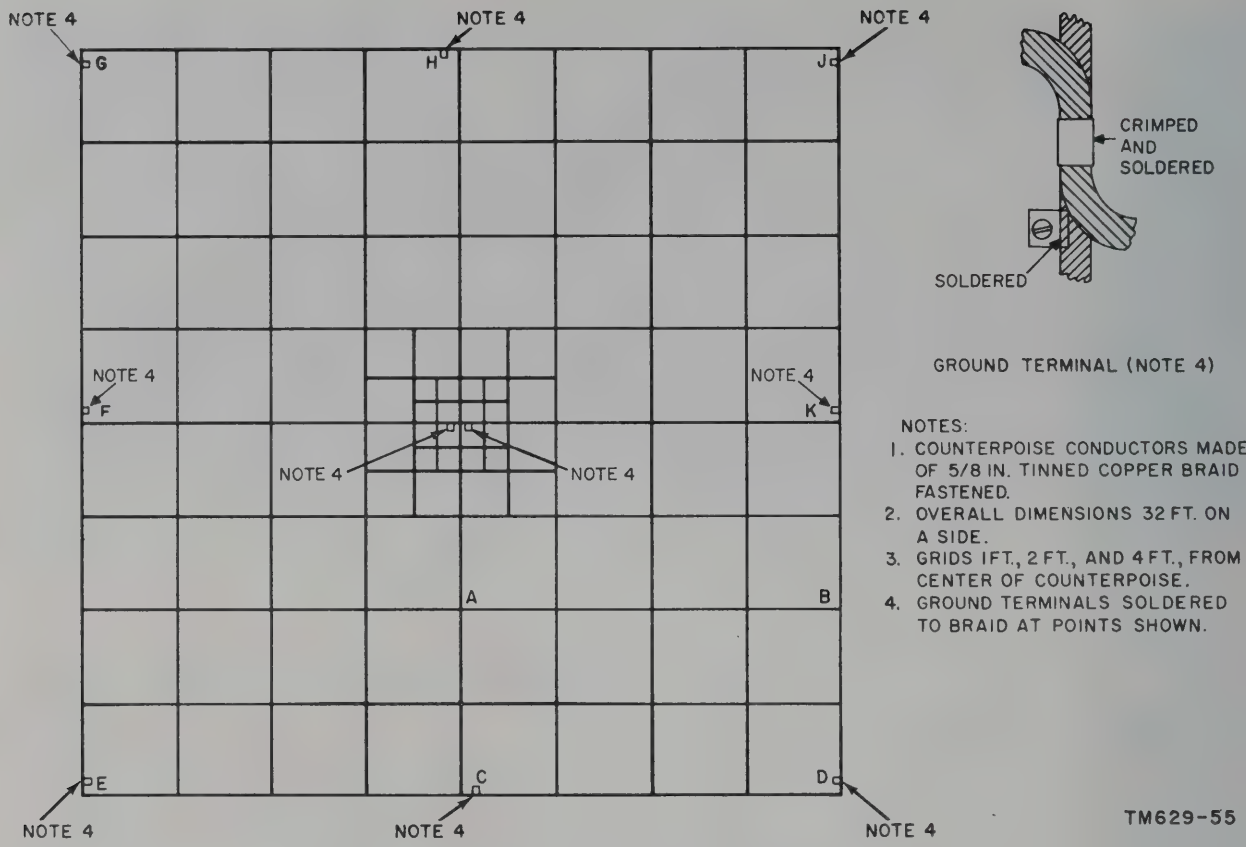

Figure 14. Counterpoise installed.

on the stub and position it so that the drainage hole points toward the east anchor rod.

c. Place the slotted end of Mast Section AB–253/GR over the top end of Mast Section AB–252/GR and, after firmly seating the section, tighten the clamp to secure the two sections together.

d. Place a guy plate over the upper end of the second mast section with the concave surface toward the antenna base, and allow it to come to rest against the guy collar.

e. Assemble the remaining mast sections in a similar manner. Place the guy plates for the two top guying positions over the upper ends of Mast Sections AB–255/GR and AB–257/GR.

f. Assemble three Mast Sections MS–116A and thread the lower Mast Section MS–116A into the socket at the top of Mast Section AB–257/GR.

Note. When assembling the mast sections, aline the sections so that the mast section sleeve clamps will be on the east side of the mast.

32. Attaching Guys

(fig. 18)

When attaching guys to the guy plates, anchor rods, and gin pole, prevent crossovers and kinks from appearing in the guy cables. Check all guy insulators for cracks or chips. Directions are given below for attaching guys to one monopole. Guys are attached to the other three monopoles in an identical manner.

a. Place Guys MX–1319/GR, MX–1320/GR, and MX–1321/GR at each anchor rod. The guys unroll from the turnbuckle end; therefore, attach them to the anchor rods first.

b. Attach the turnbuckle end of the guys at the north anchor rod to the north anchor rod. Adjust the turnbuckles to half takeup.

c. Pay out Guy MX–1321/GR (35 ft 0 in.) from the north anchor rod and attach it to an eye of the lowest guy plate.

d. Pay out Guy MX–1320/GR (46 ft 11 in.) from the north anchor rod. Attach it to the eye of the

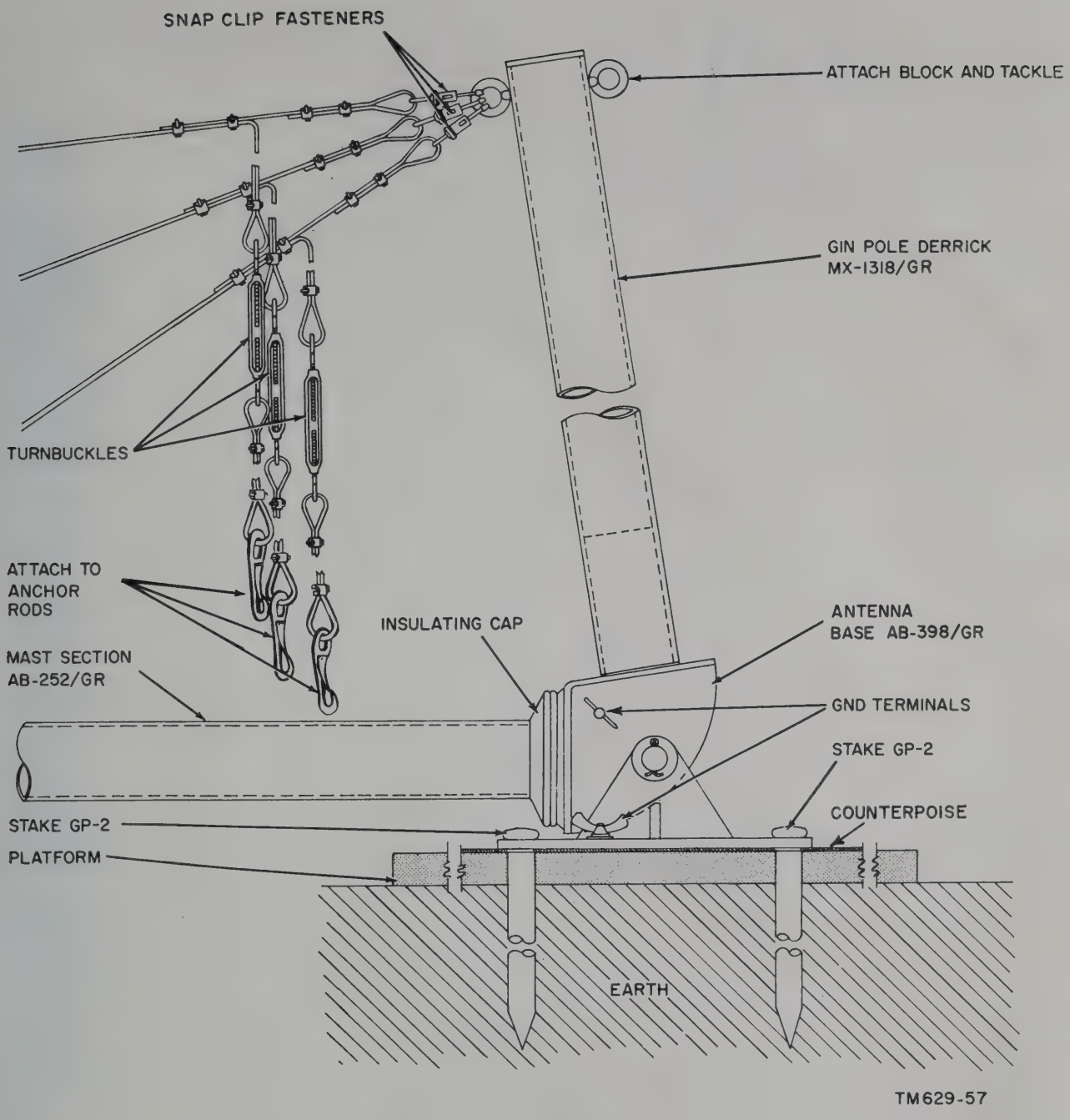

Figure 15. Installing antenna base.

center guy plate on the monopole by means of its snaphook fastener.

e. Pay out Guy MX–1319/GR (61 ft 10 in.) from the north anchor rod. Attach it to the top guy plate on the monopole by means of its snaphook fastener.

f. Check the north guys after they are attached, for crossovers and kinks.

g. Proceed with attaching the east and west guys in the same manner as in *a* through *f* above. Always attach the guys to the anchor rod first and pay them out separately, beginning with the guy to the bottom guy plate.

h. The south guys must be attached to the gin pole by means of the takeoff snaphook fasteners

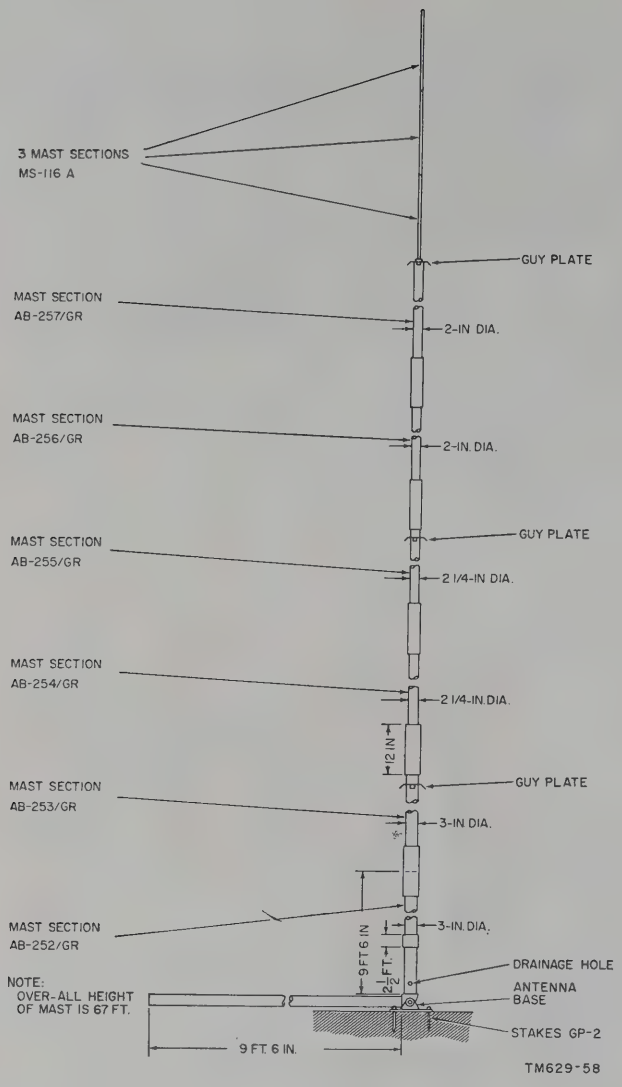

Figure 16. Monopole assembly.

before raising the mast. Refer to paragraph 33 for instructions.

Note. The guys are shipped by the manufacturer with the turnbuckles set to half takeup. All guys will be of correct length for raising the monopoles, provided the anchor rods are positioned properly. Irregular terrain or other site features that require an unsymmetrical anchor rod layout can be compensated for by adjusting the turnbuckles or readjusting the guy cable lengths by loosening the cable clamps.

33. Assembling Gin Pole

Gin Pole Derrick MX–1318/GR and block and tackle are used only for raising the masts of the antenna array. A spare gin pole is furnished and may be used for raising the other masts if enough personnel and another block and tackle are available. The gin pole and block and tackle must be assembled as shown in figures 15 and 18 and as described below.

a. Attach the draw end of the block and tackle to the ring at the top of the gin pole, as shown in the inset of figure 18.

b. Attach the south guys to the inner ring of the ring bolt at the top end of the gin pole by means of the snaphook fasteners on the center tap assemblies of each south guy. The turnbuckles are attached to the south guy stake after the mast has been raised.

c. Place the gin pole over the gin pole stub of the antenna base and position it so that the block and tackle is to the south and the guys are to the north (fig. 19). Make sure that the gin pole is properly locked in place on the gin pole stub.

d. Extend the block and tackle to a length that will allow its free end to reach and attach to the guy ring assembly on the raising stake.

e. Draw up the block and tackle by means of the draw rope until all slack is taken out.

Note. When attaching the block and tackle to the gin pole, insert the pin of the shackle through the ring bolt of the gin pole. The shackle ring bears on the coupling link of the block. See inset on figure 18.

34. Raising the Masts

(fig. 19)

Before raising a mast, check all guy assemblies for defects. Make sure that no crossovers or kinks are in the cables. Check to see that all snaphook fasteners are secure. Any deficiency can cause injury to personnel and possible damage to the antenna equipment. It is recommended that a minimum of three men be used for raising a mast. Assign two men to the block and tackle draw rope. The third man will check the mast for bending while raising and also will be able to keep the guy assemblies from becoming entangled.

a. Raise the north mast by slowly taking up on the draw rope. If there is any tangling of guy assemblies, stop the takeup on the draw rope and have the third man untangle and separate them.

b. When the mast is in a vertical position, detach the south guys from the gin pole one at a time and attach them to the guy ring assembly on the south anchor rod.

Caution: Do not release the block and tackle when transferring the guy assemblies.

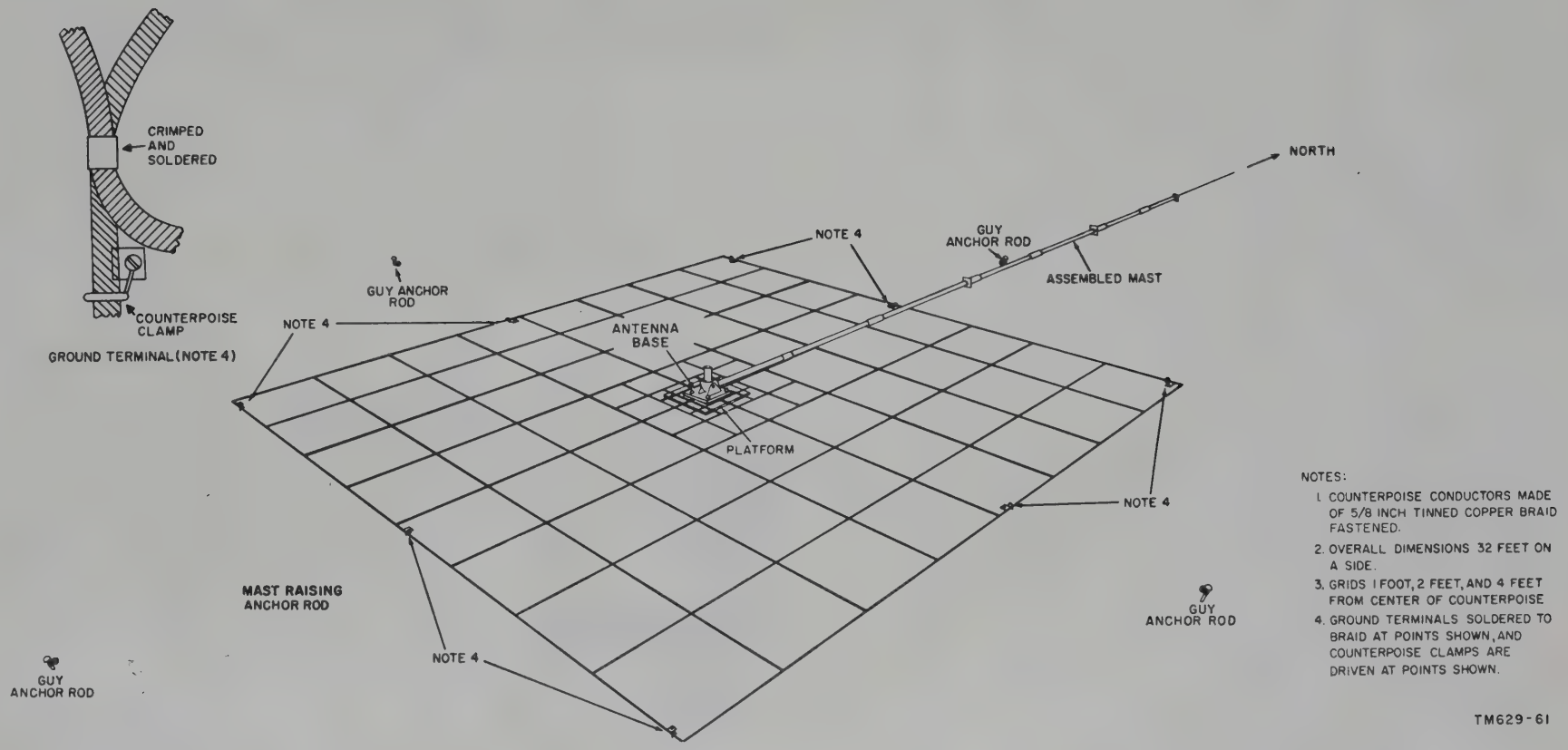

Figure 17. Placing monopole on counterpoise.

c. Adjust all turnbuckles to straighten the mast. Use the rod level to check that the mast is exactly vertical. Bends in the mast can be removed by adjusting the proper turnbuckles in opposition to each other. Take up on the turnbuckle on the concave side of the mast while letting out on the turnbuckle on the convex side. Two men are necessary for this operation.

d. After the mast has been erected and all adjustments made to the guy assemblies, remove the block and tackle from the gin pole and from the guy ring assembly on the mast-raising anchor rod. Remove the gin pole from the gin pole stub. Carry the block and tackle and gin pole to the next mast to be raised. Proceed as instructed in *a* through *c* above for the east, south, and west masts.

e. When raising the mast and during adjustment in the vertical position, observe the following precautions:

(1) Do not allow the guy assemblies to become too tight during the raising of the mast.

(2) Do not allow any guy assemblies to become entangled.

(3) Do not stand under the mast during raising operations and do not allow assisting personnel to stand in the danger area of guy assemblies and mast.

(4) Always check each mast for leaning, after it is raised, by the use of the rod level.

35. Installing Antenna Couplers (fig. 20)

The antenna couplers provide an electrical connection from the RF transmission lines to the base of each monopole. Figure 20 illustrates an antenna coupler mounted on its mounting collar at the base of one antenna mast. To install each antenna coupler, proceed as follows:

a. Loosen the screws of the clamp and open the hinge of the clamp.

b. Position the antenna coupler on the collar of the mast near the mast base so that the ground lug

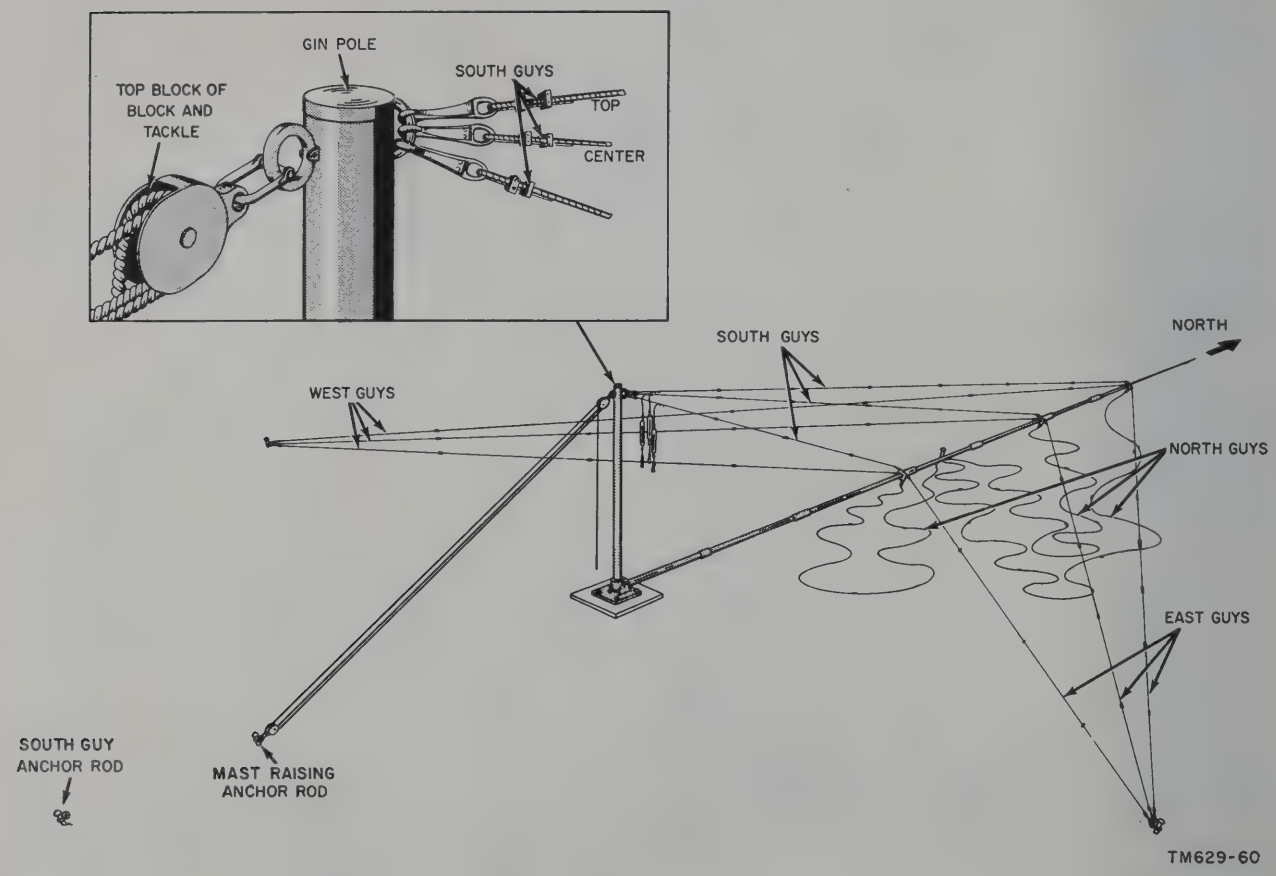

Figure 18. Attaching guy assemblies.

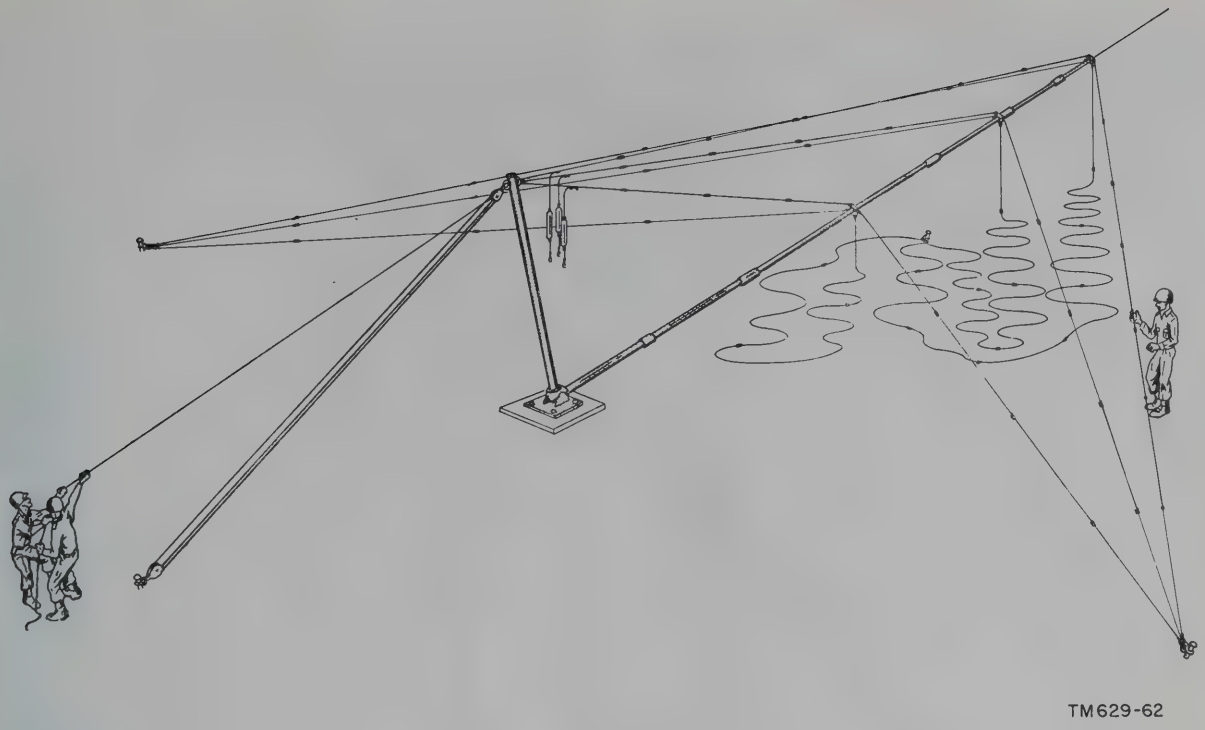

Figure 19. Raising the mast.

on the coupler is directly over the ground lug on the mast base.

c. Place the hinged clamp around the collar of the mast and tighten the screws.

Caution: When the clamp is nearly tight, rotate it slightly in both directions to insure good electrical contact. Remove mud, grease, or corrosion from the contacting surfaces of the clamp bracket, as well as the mast collar, because a poor connection will result in an unbalance of the entire system.

d. Connect the ground braid to the screw on the side of the antenna coupler case.

e. Install the remaining three antenna couplers on the other monopoles of the antenna system in a like manner.

36. Installing RF Cables

The four color-coded RF cables are contained in the reel assembly chest. These must be unrolled and connected to the base connector of the antenna couplers. Connect the GREEN RF cable to the north antenna, the YELLOW RF cable to the south antenna, the BLUE RF cable to the east antenna, and the BROWN RF cable to the west antenna. Refer to figure 20 for an illustration of an RF cable connected to an antenna coupler.

a. Open the reel case and position the roller by lifting it upward and pulling it forward (fig. 21). Secure the roller by engaging a projection on the roller assembly with the center cover latch.

b. Unroll each RF cable individually and in the direction of the antenna to which it is to be connected. Unroll the RF cables near the center of the roll first. If the reel assembly is located at the center of the site or near the shelter, the connections may be made more quickly, and with less chance of damage to the cables. *Do not unroll the cable assemblies too fast;* they might become damaged. Avoid getting sand or other foreign material inside the coaxial-type connectors which terminate the cables.

c. Pass the RF cable assemblies beneath the elements of each counterpoise when approaching the masts. This will remove the transmission lines from the direct field of the antennas at points nearest the monopoles.

d. Remove the protecting cap from the coaxial-type connector at the bottom of the antenna coupler and connect the RF cable. Make sure that the

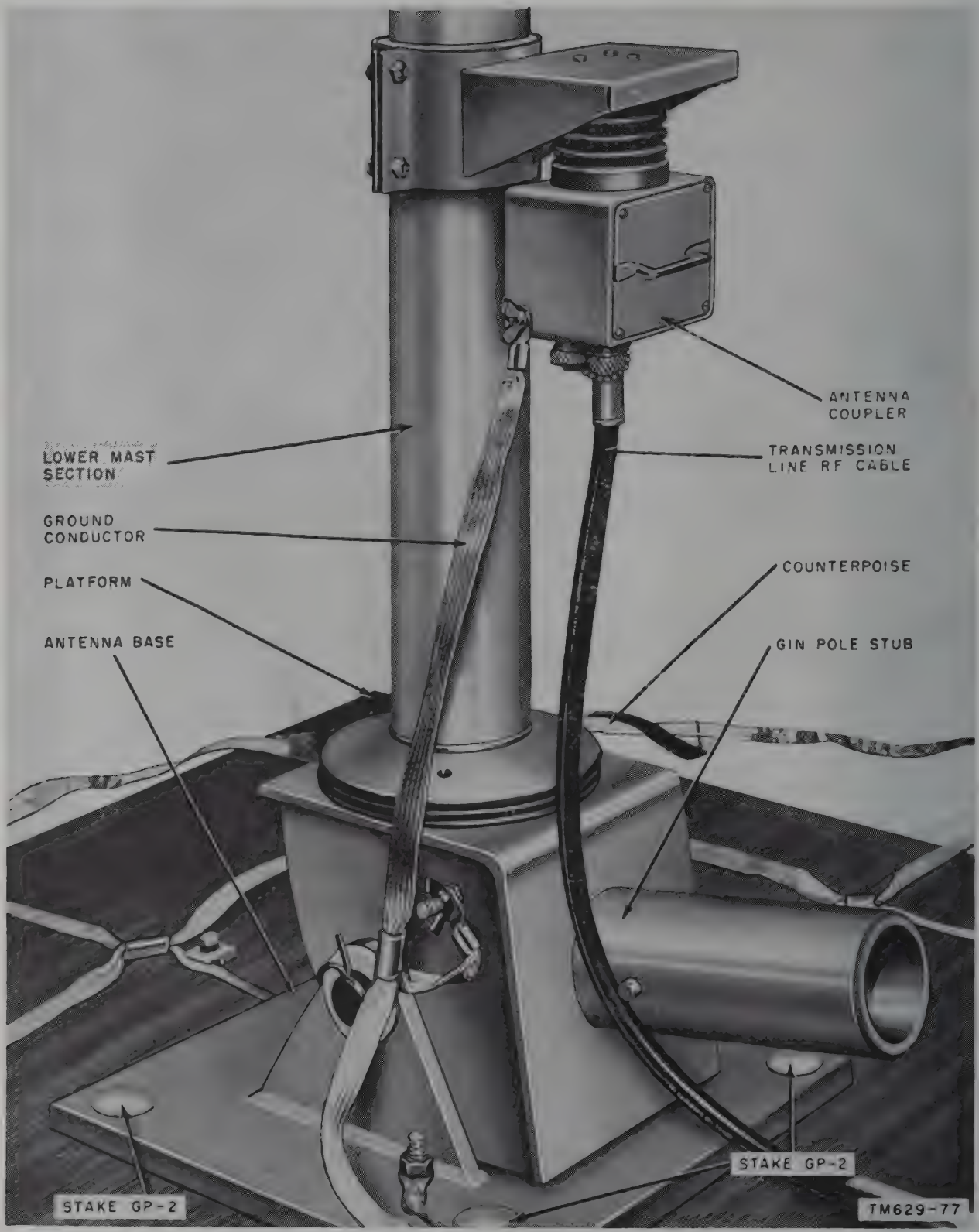

Figure 20. Antenna base and antenna coupler.

cable connector is drawn fully up on the threads of the antenna coupler connector.

e. Remove all bends in the cables so that they run in a straight line toward the center of the array.

f. Pass the free ends of the cables through the cable boot opening in the north side of the shelter.

Caution: Never step on, bend, or kink the RF cables. Do not allow vehicles in the antenna area.

Figure 21. Hand Cable Reeling Machine RL–182/G.

37. Unpacking Electrical Equipment Cases

a. The goniometer drive rack with the goniometer and goniometer drive and the indicator rack with the azimuth indicator are packed in the indicator case shown in figure 22.

b. The receiver rack with the receiver is packed in the receiver case shown in figure 23. This case also contains instruction manuals, interconnecting cables, electrical running spare parts, and spintite wrenches.

c. The goniometer drive rack, the azimuth indicator rack, and the receiver rack are attached to the cases by retaining bolts that are threaded into the rack shock mounts. Each rack is held in place by six bolts.

d. All retaining-bolt assemblies are identical. To remove the retaining bolts, refer to figure 24 and proceed as follows:

(1) Remove the two machine screws that hold the bolt-retaining flange.

(2) Remove the retaining bolt.

(3) Remove the bolt-retaining flange.

e. When the six retaining bolts have been removed from each rack, the rack can be removed from the case.

f. The goniometer drive rack and the azimuth indicator rack are identical in physical detail. Their positions in the case can be reversed from the positions shown in figure 22.

g. All hardware should be saved for future use.

38. Equipment Installation in Shelter S–44/G (fig. 25)

a. Remove the racks from their individual cases (par. 37).

b. Assemble the mounting table. Place it in a convenient position in the shelter.

c. Release the clamps and bolts as shown in figures 26 through 28.

d. Place the electrical equipment racks with their installed components on the operating table.

e. Place the junction box beneath the operating table.

f. Mount the terminal box on the wall of the shelter directly over the cable boot (fig. 25).

g. Proceed with the equipment connections in the shelter as described in paragraph 39.

39. Connecting Operating Components (fig. 29)

a. Connect primary power cable W812 to the power unit. Unroll it and pass it through the cable boot opening in the north side of the shelter through which the antenna transmission lines pass.

b. Connect the free end of the power cable to the wingnut screws in the terminal box. To reach the connections in the terminal box, the power cable must be passed through the bottom opening of the

Figure 22. Indicator Case CY–1853/TRD–3.

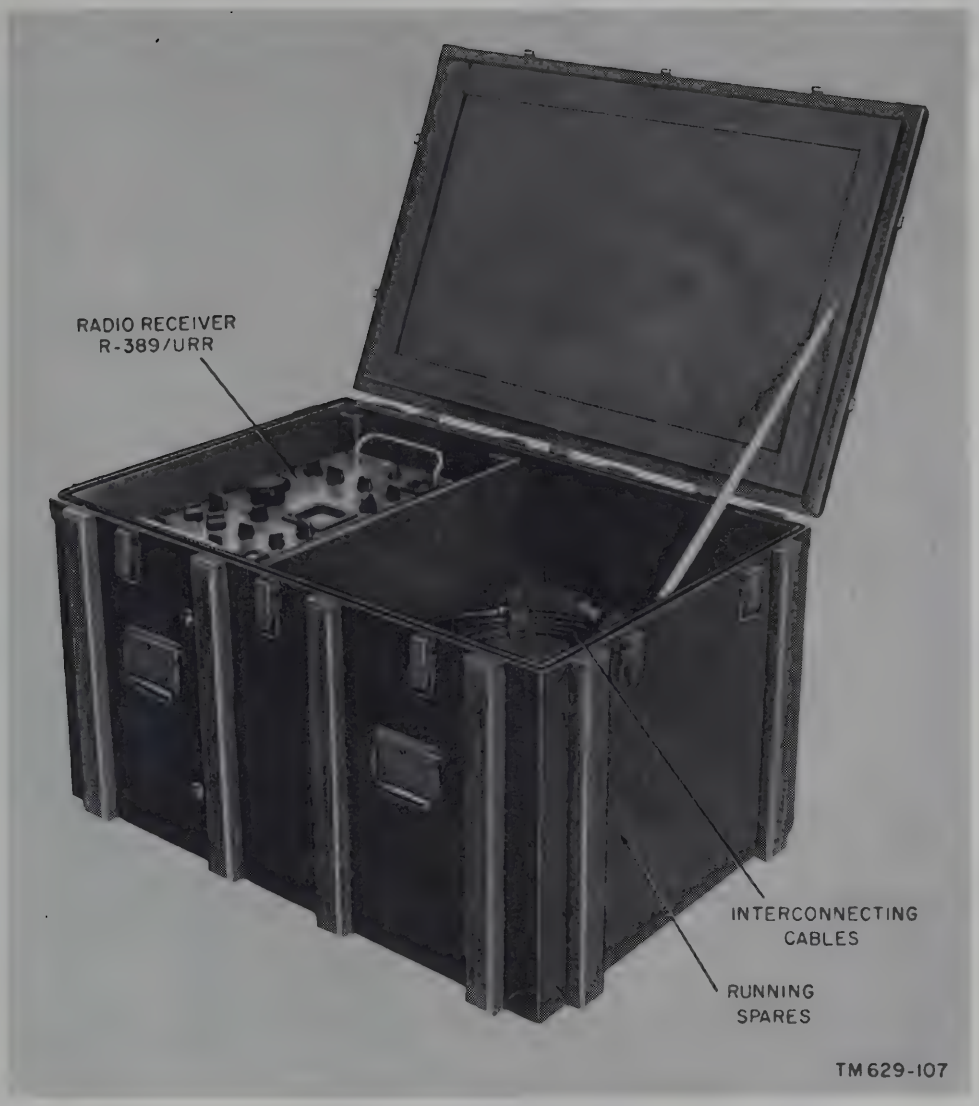

Figure 23. Receiver Case CY–1852/TRD–3.

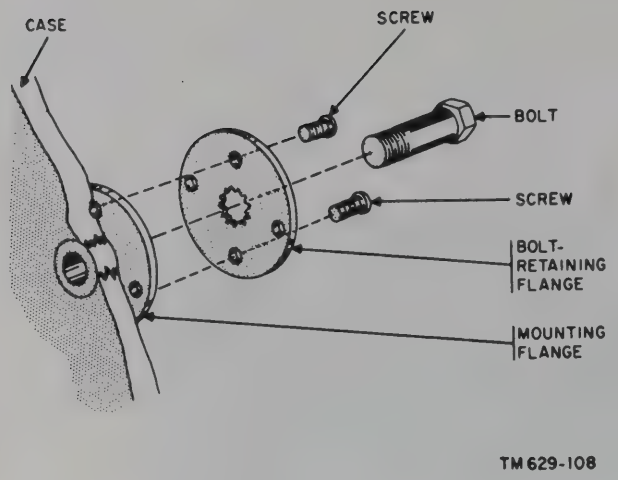

Figure 24. Retaining-bolt assembly.

box. Secure the cable with the cable clamp on the terminal box.

c. Pass power cable W815 from the junction box through the opening on the top right side of the terminal box. Connect the leads to the center pair of terminals in the terminal box. This is the power source for operating all equipment.

d. Pass power cable W816 from the shelter circuit breaker through the opening on the top left side of the terminal box. Connect the leads to the top pair of terminals in the terminal box. (This is the shelter lighting circuit and utility outlet connection.) The shelter ventilating system and heater are also connected by this operation.

e. Make interconnections of equipment to the

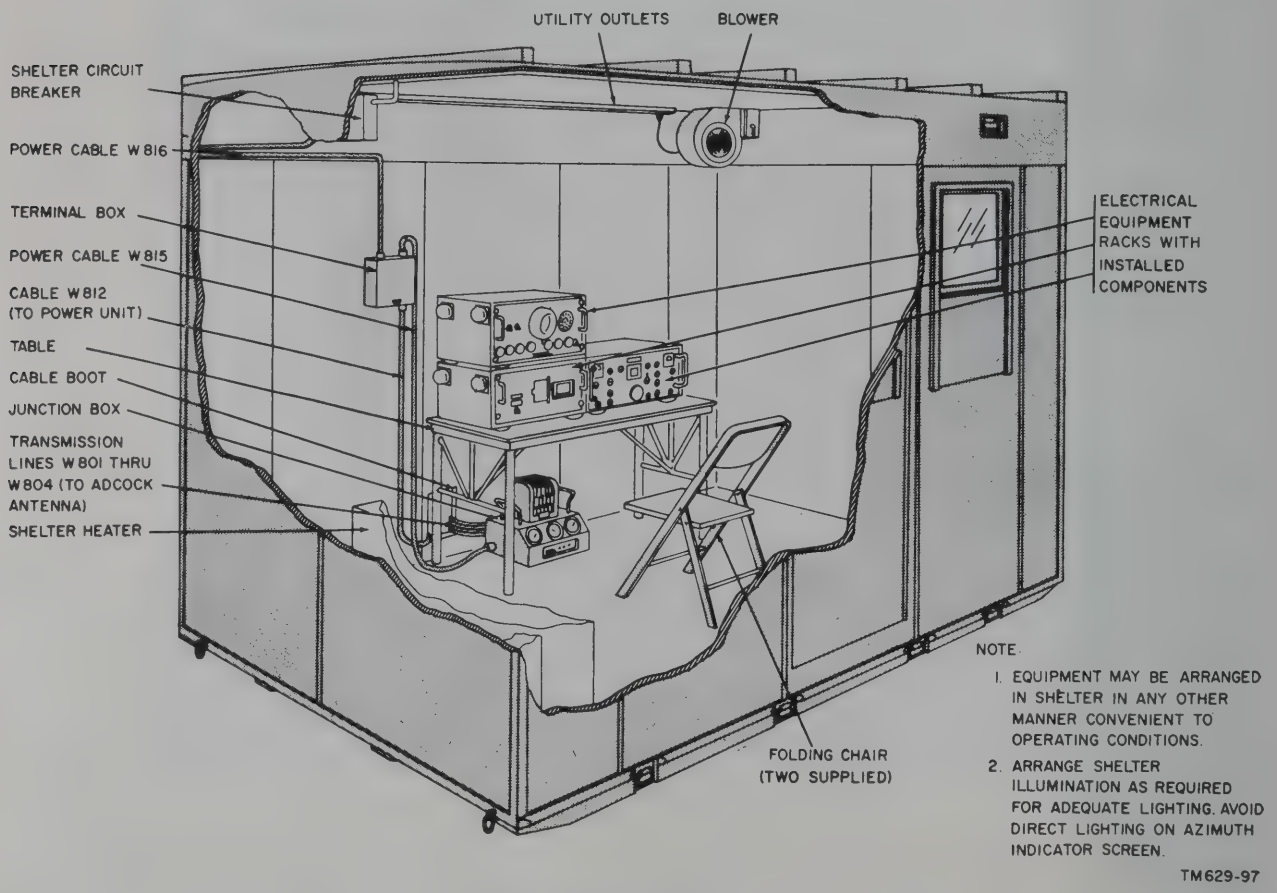

Figure 25. Placing equipment in shelter.

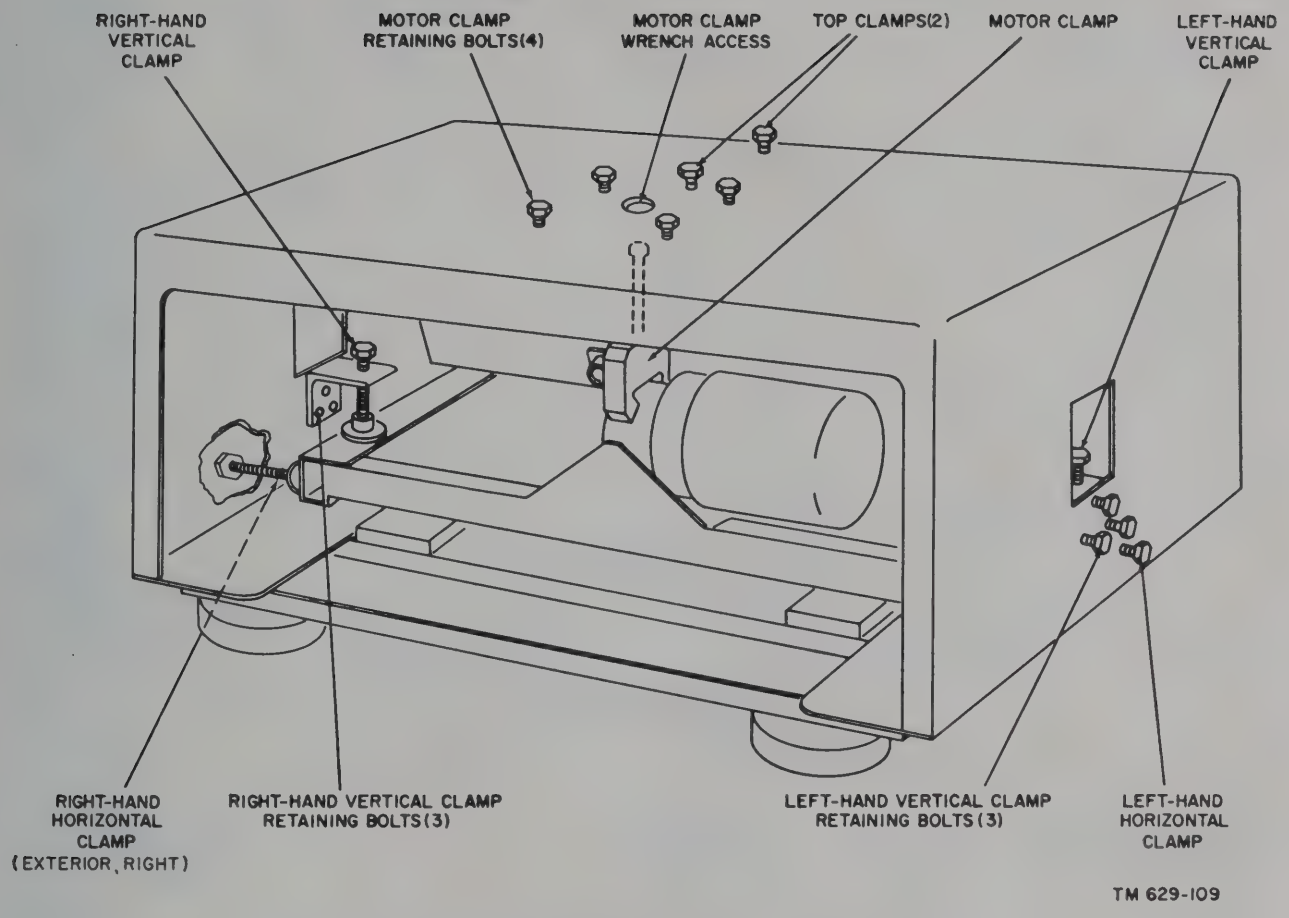

Figure 26. Goniometer Drive MX–1170/GRD, chassis clamping points.

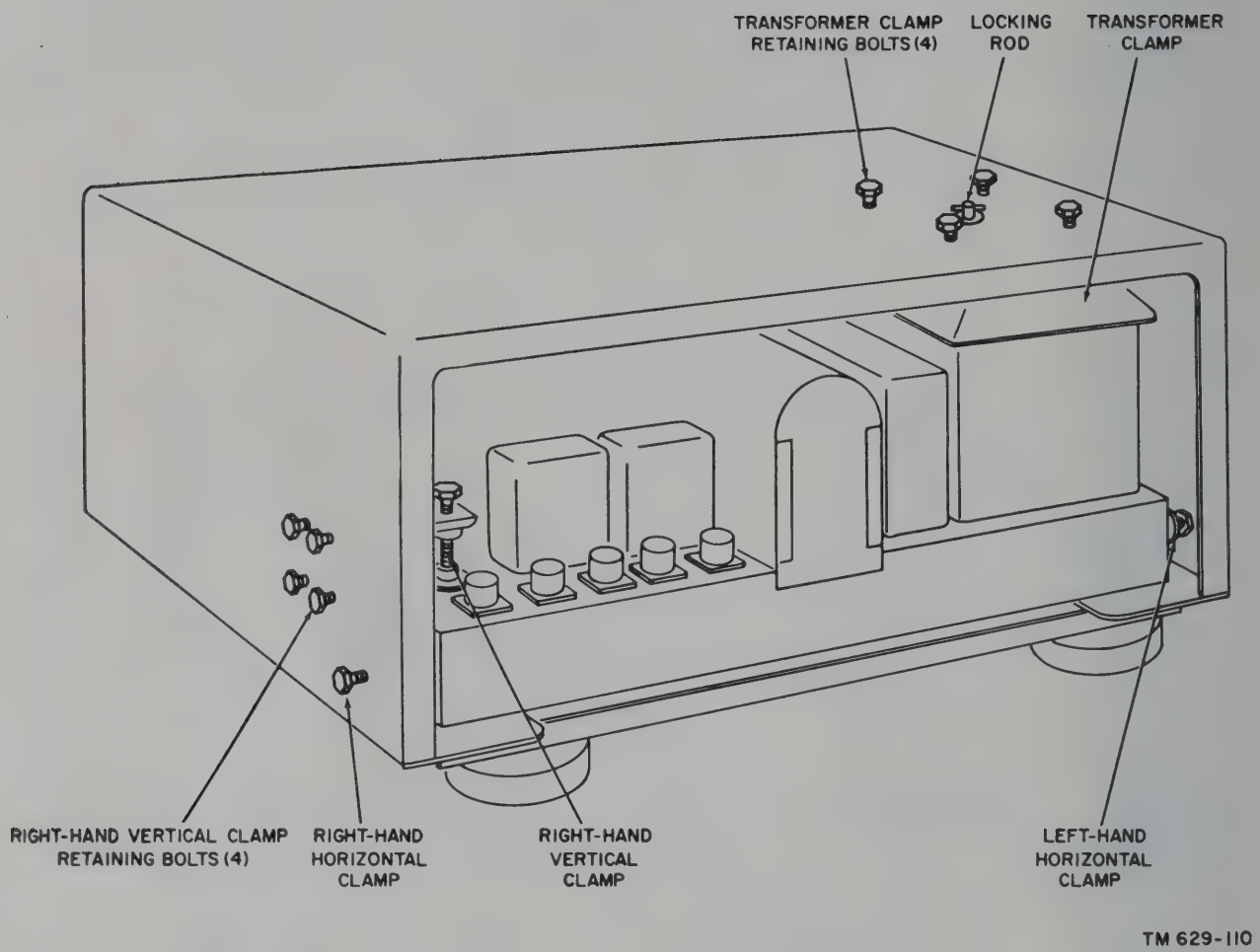

Figure 27. Azimuth Indicator IP–137/GRD, chassis clamping points.

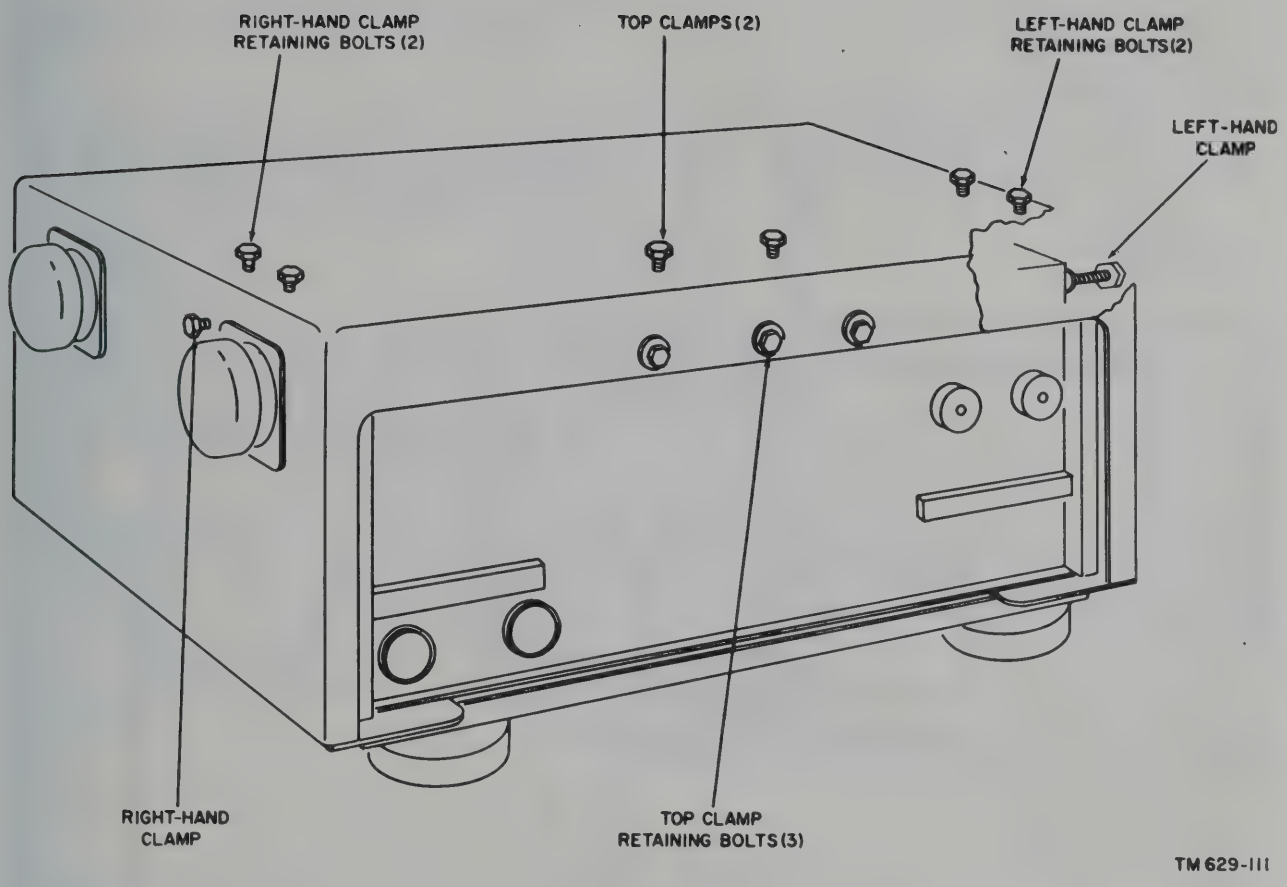

Figure 28. Radio Receiver R–389/URR, chassis clamping points.

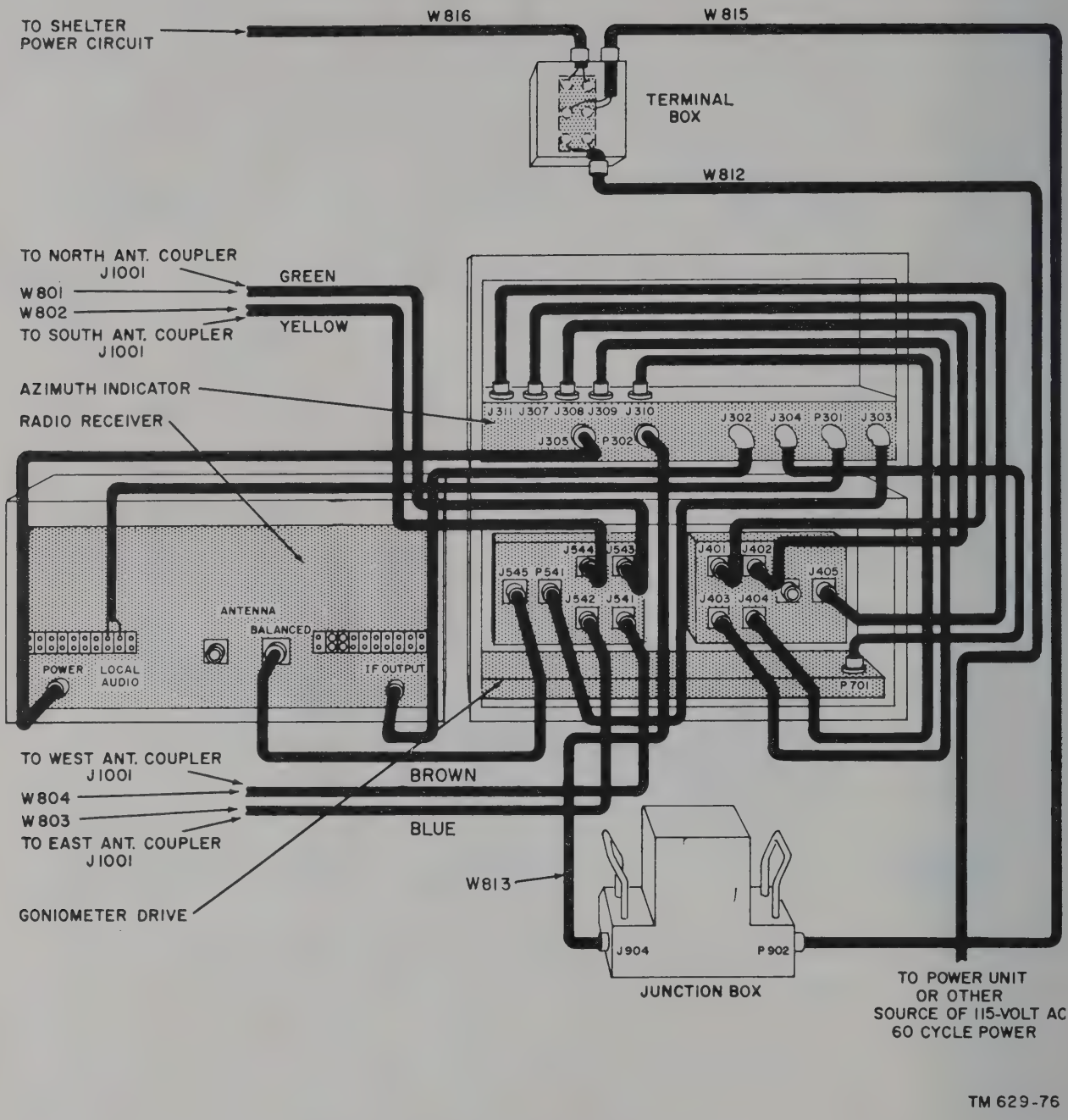

Figure 29. Operating components cabling diagram.

electrical equipment cabinets according to the cabling diagram (fig. 29). Recheck these connections to make sure that they are correct.

f. Connect the antenna RF cables to the signal goniometer. The jack and cable reference numbers are as shown in figures 29 and 31.

Caution: Do not allow the protective plug caps fastened on chains to fall near the goniometer drive belt.

g. Connect the power cable from the azimuth indicator to the junction box at J904 (fig. 31). This connection will permit ac power to be applied to all operating equipments.

h. Recheck all connections. Refer to figures 29 and 31 for all cabling information. Refer to the cabling check chart (par. 40) for a summary of cables used and their connections.

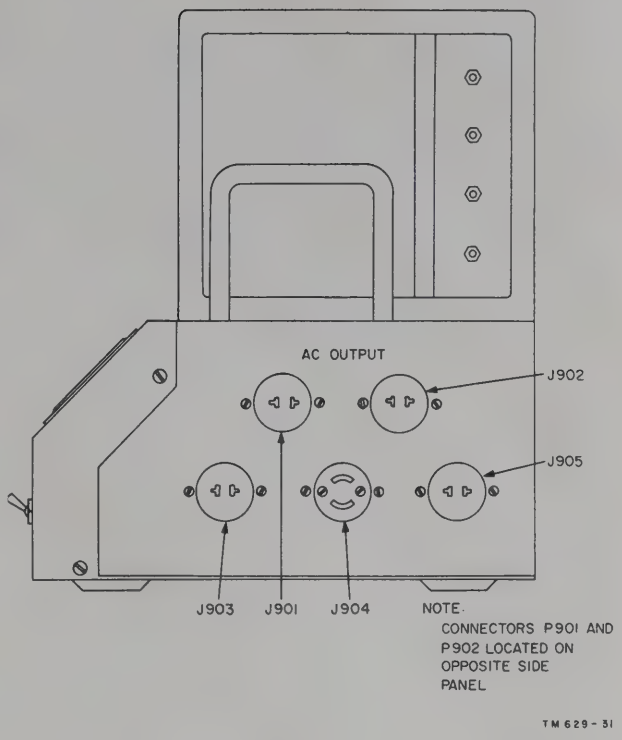

Figure 30. Power connections to junction box.

40. Equipment Cabling Check Chart

Ref symbol	Cable	Rqr No.	Length	Connects	
				From	To
W801, W802, W803, W804	CG–1256/TRD–3	4	125 ft	Antenna coupler	Signal goniometer
W805	CG-1257/U	1	2 ft, 8 in.	Radio receiver IF output	Azimuth indicator IF input
W806, W807, W808, W809	CG–1078/U	4	3 ft, 7 in.	Indicator goniometer	Azimuth indicator
W810	CG–1079/U	1	4 ft, 1 in.	Azimuth indicator	Indicator goniometer
W811	CG–1079/U	1	3 ft, 8 in.	Signal goniometer rotors	Receiver antenna input terminals.
W812	CX-2965/U	1	300 ft	Power unit	Shelter
W813	CX–2381/U	1	10 ft	Junction box	Azimuth indicator
W814	CX–3330/U	1	2 ft, 10 in.	Azimuth indicator	Goniometer drive
W815, W816	CX–2383/U	1	12 ft	Terminal box	Junction box
		1	12 ft	Shelter circuit	Terminal box
W817	CX–3331/U	1	3 ft, 2 in.	Azimuth indicator	Signal goniometer (sense relay).
W818	CX–3332/U	1	3 ft, 10 in.	Receiver	Azimuth indicator (speaker terminals).
Part of radio receiver.	CX–1358/U	1	8 ft	Receiver power	Azimuth indicator
W601	CX–2966/U	1	8 ft, 3 in.	Target transmitter	Ac power source

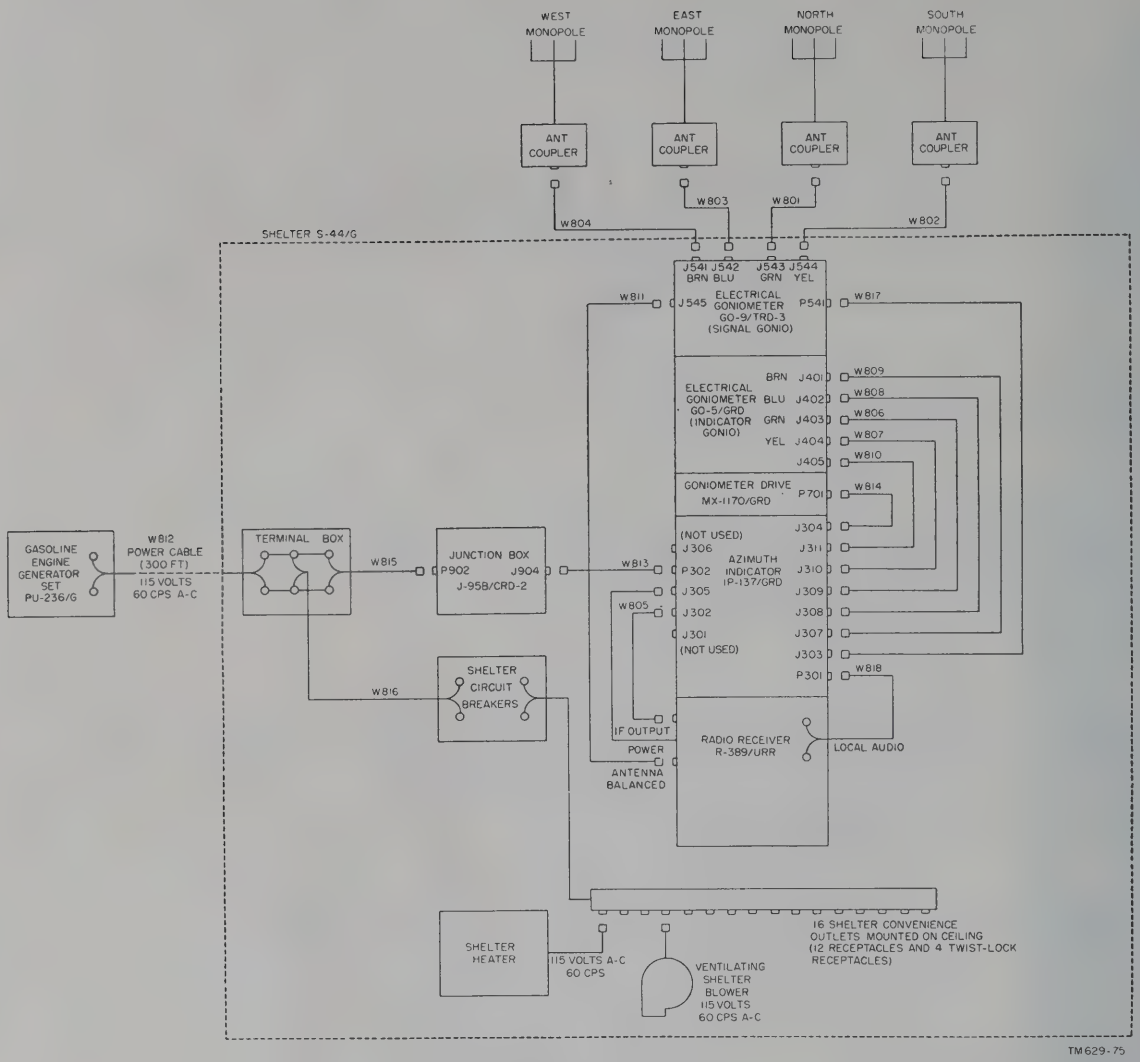

Figure 31. System cabling diagram.

Section II. INITIAL ADJUSTMENT OF EQUIPMENT

41. Checking Direction Finder Set After Installation

When all components of the system have been installed and the cables connected and checked against the cable check chart (par. 40), the system should be turned on and given a preoperational check to determine that each unit is operating satisfactorily. Use equipment performance checklist (par. 74) as a guide to performance. Certain preoperational adjustments of the goniometer drive and azimuth indicator will be necessary. Refer to paragraphs 42 and 43 for additional information.

42. Initial Adjustment of Goniometer Drive

The position of the propeller-shaped pattern on the cathode-ray tube must be adjusted so that it corresponds to the physical orientation of the antenna system. To accomplish this, the signal goniometer housing is rotated; this causes the pattern to shift. The following method may be used to orient the goniometer with the antenna.

a. Remove the east and west antenna couplers from the masts and leave the cables connected. Place the couplers on some insulating material such as dry wood to prevent accidental grounding.

b. Set up the target transmitter on the north side of the antenna system exactly in line with the north-south antenna at a distance of approximately 1,000 feet and transmit a cw signal at 500 kc.

c. Turn the azimuth indicator on, and adjust the circular pattern as described in paragraph 54. Be sure to use the 2-kc selectivity position on the receiver. Tune the receiver to the transmitter frequency to produce the propeller pattern.

d. At the goniometer drive, loosen the forward knurled screw (swivel plate lock) at the top of the drive assembly (fig. 33) to free the swivel plate. If the antenna system has been erected and positioned as described in paragraph 25, rotate the signal goniometer housing until the propeller pattern points to 0° and 180°. Tighten the knurled screw (swivel plate lock) to lock the goniometer in this position.

e. If the antenna system has not been physically oriented exactly to north, it will be necessary to compensate for the amount of deviation. Corrections of up to 20° can be made in the following manner:

(1) Determine the number of degrees and direction that the north antenna deviates from north by using the compass at the exact center of the antenna system.

(2) Rotate the pattern in the *same* direction and for the same number degrees as the north antenna deviates from north.

Example. If the north antenna is located at 10° east of north, set the pattern to 10° on the azimuth scale of the azimuth indicator. If the north antenna is 7° west of north, set the pattern at 353°.

f. Replace the east and west antenna couplers.

43. Checking Visual Bearings for Accuracy

a. The accuracy of the direction finder set should be checked after the equipment has been installed and given a preoperational check (par. 74). The most practical method is to tune in a known signal and check the visual (and aural) barings by plotting the position of the station with respect to the site of the direction finder set.

b. The target transmitter is used to check the accuracy of the direction finder set.

(1) With the direction finder set turned on and warmed up, carry the target transmitter to a distance of 1,000 feet from the Adcock antenna system and at an azimuth of 270° (west).

(2) Erect the target transmitter antenna (assemble the 5-section whip) and turn on the transmitter. Transmit a signal at 500 kc.

(3) Set up and adjust the compass and tripod (par. 25 and fig. 10) and allow the plumb line and bob to line up exactly with the geometrical center of the antenna array. (Use the stake originally set to locate the site center.)

(4) Point the compass sight toward the target transmitter and, by signaling to the man at the target transmitter, correct the position of the transmitter so that it is positioned exactly 270° by the compass scale.

(5) Swing the compass sights until the east antenna (90°) is lined up. See that the target transmitter is lined up exactly with the east and west antennas.

(6) Follow the procedure for obtaining visual bearings (par. 54), and take a bearing on the target transmitter signal. The propeller pattern should point to 270° with one tip while the other tip points to 90° on the azimuth indicator scale.

(7) Press the sense switch. The arrowhead pattern should indicate a signal direction of 270°.

(8) Bearings should be checked in each quadrant at other frequencies. To determine whether the azimuth scale of the goniometer drive requires further adjustment and orientation (par. 44), turn off the goniometer drive motor and take aural bearings of each signal checked by the visual method.

44. Azimuth Scale Orientation

Before the azimuth scale on the goniometer drive can be used to take bearings by the aural-null method, it must be adjusted to give the same reading as the alidade on the visual indicator.

a. Set up the target transmitter to transmit on a frequency of 500 kc. Adjust the receiver to receive the signal transmitted by the target transmitter. Carry the target transmitter to a point north of the north antenna and directly in line with the north-south antennas. Be sure to place the target transmitter more than 1,000 feet from the north antenna to avoid the primary field of the antenna system.

b. Obtain a visual pattern on the azimuth indicator of the signal transmitted by the target transmitter. This propeller pattern should have its tips pointing near 0° and 180°. Record the reading.

c. Turn off the motor in the goniometer drive. Rotate the azimuth scale slowly past the 0° mark (white scale). The aural-null (position of minimum signal) from the target transmitter should occur at the recorded reading. If it does not, proceed as follows:

(1) Loosen the index lock and the knurled screw toward the rear of the top of the drive assembly. Move the index arm until the engraved index mark is directly opposite the same azimuth reading on the white azimuth scale as the visual bearing. When making these adjustments, be sure that the azimuth scale remains at the null position. Refer to figure 33 for the goniometer drive adjustments.

(2) Tighten the index lock to lock the index in this position.

CHAPTER 3

OPERATION

Section I. CONTROLS AND INSTRUMENTS

45. General

Indiscriminate operation and improper setting of the controls may cause damage to the direction finder set. The operator, therefore, should familiarize himself with the controls and their functions before attempting its operation. The SENSE switch on the indicator goniometer is not used in this equipment. The SENSE switch on the azimuth indicator is used to obtain the true bearing. It should be left in the ADCOCK position at all times. The following is a list of controls that must be properly adjusted to prevent damage to equipment.

a. Be certain that the LINE INPUT switch on the junction box is set for the proper voltage 115 volts or 230 volts (fig. 32).

b. Be certain that the OUTPUT VOLTAGE CONTROL is set so that the OUTPUT VOLTAGE meter indicates the proper operating voltage. Too high a setting may damage or shorten the life of the equipment.

c. Do not allow a single spot beam to remain on the screen of the azimuth indicator (fig. 34). The concentrated beam will burn a spot on the fluorescent screen.

46. Controls and Instruments for Junction Box J–95B/CRD–2
(fig. 32).

The following table lists the controls and instruments of the junction box and indicates their functions.

Control or instrument	Function
OUTPUT VOLTAGE meter	Indicates the output voltage of the junction box.
LINE FREQUENCY meter	Indicates the frequency of the power supply voltage.
LINE INPUT 115V–OFF–230V switch.	Connects input power to the proper tap on the line voltage transformer for 115- or 230-volt operation.
OUTPUT VOLTAGE CONTROL switch.	Permits adjustment of output voltage to 115 volts.
CIRCUIT BREAKERS 115V. and 230V.	Reset for circuit breakers.
OUTPUT LOAD EQUIPMENT-OFF-DUMMY switch.	Applies ac supply voltage to either the equipment or the dummy load.

47. Controls for Goniometer Drive MX–1170/GRD
(fig. 33)

The following table lists the controls of the goniometer drive and indicates their functions.

Control	Function
Azimuth scale	For turning the two goniometer rotors manually for aural-null reception.
Index lock	Locks the index mark.
Swivel plate lock	Locks the signal goniometer housing.
GONIO-DRIVE COLD START switch.	Starts motor of goniometer drive at subzero temperatures.

48. Controls for Azimuth Indicator IP–137/GRD
(fig. 34)

The following table lists the controls of the azimuth indicator and indicates their functions.

Control	Function
MAIN POWER ON-OFF switch.	Connects the power source to the azimuth indicator, goniometer drive, and receiver.
INDICATOR ON-OFF switch.	Turns the azimuth indicator ON or OFF.

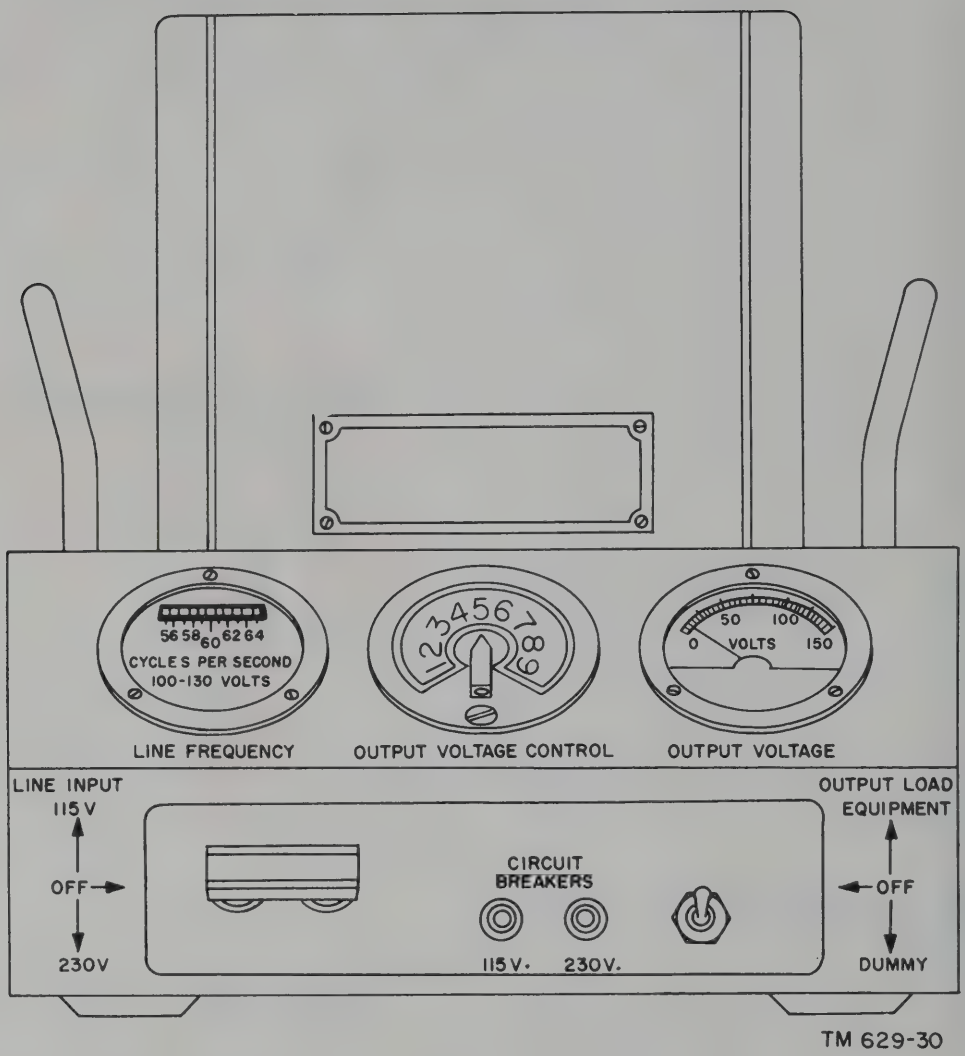

Figure 32. Junction Box J–95B/CRD–2, controls.

Control	Function
GONIO-DRIVE ON-OFF switch.	Turns the goniometer drive ON or OFF.
INTENSITY control	Varies the brightness of the pattern.
FOCUS control	Adjusts sharpness of the cathode-ray tube pattern.
HORIZONTAL and VERTICAL controls.	Centers the cathode-ray tube pattern.
SENSE switch	Changes false bearing pattern to a sense pattern when depressed. Refer to A, figure 37.
DIMMER control	Varies intensity of light on the azimuth scale and alidade.
SIZE control	Varies diameter of the cathode-ray tube pattern.
SHAPE control	Makes the no-signal pattern circular.
Alidade control	Moves crossed hairline on face of cathode-ray tube.
Alidade locking screw	Locks the alidade in place.

49. Antenna Coupler

The antenna coupler range switch (S1001, fig. 85) selects the proper impedence-matching circuit in the antenna coupler to match the antenna impedance to the transmission line impedance. When the operating frequency of the direction finder set is changed from the 100 to 300 kc range to the 300 to 1,500 kc range, operating personnel must set the antenna coupler range switch on all antenna couplers to agree with the frequency range used.

50. Radio Transmitter T–339/UR Controls (fig. 35)

The following table lists the controls of the target transmitter and indicates their functions.

Control	Function
A.C. ON-OFF switch	Turns transmitter ON or OFF.
A.C. INPUT 115V 60-cps	Receptacle for connecting 115-volt ac power cord.
BAT. ON-OFF switch	Switches battery supply into circuits of target transmitter. Disconnects power supply filter circuit.
PWR. IND.	Indicates when B+ is applied to circuits.
BAND SWITCH	Selects one of the three bands of frequencies.
MAIN TUNING	Selects individual frequency of operation in one of three bands.
DIAL LOCK	Locks the MAIN TUNING control to selected frequency.
OUTPUT	Increases or decreases cw output.
ANT. TUNING	Matches the output circuit of the target transmitter to the whip antenna.
TUNING IND.	Maximum glow indicates output circuit tuned correctly.
MOD. ON-OFF switch	Applies or disconnects modulator from power amplifier circuit.

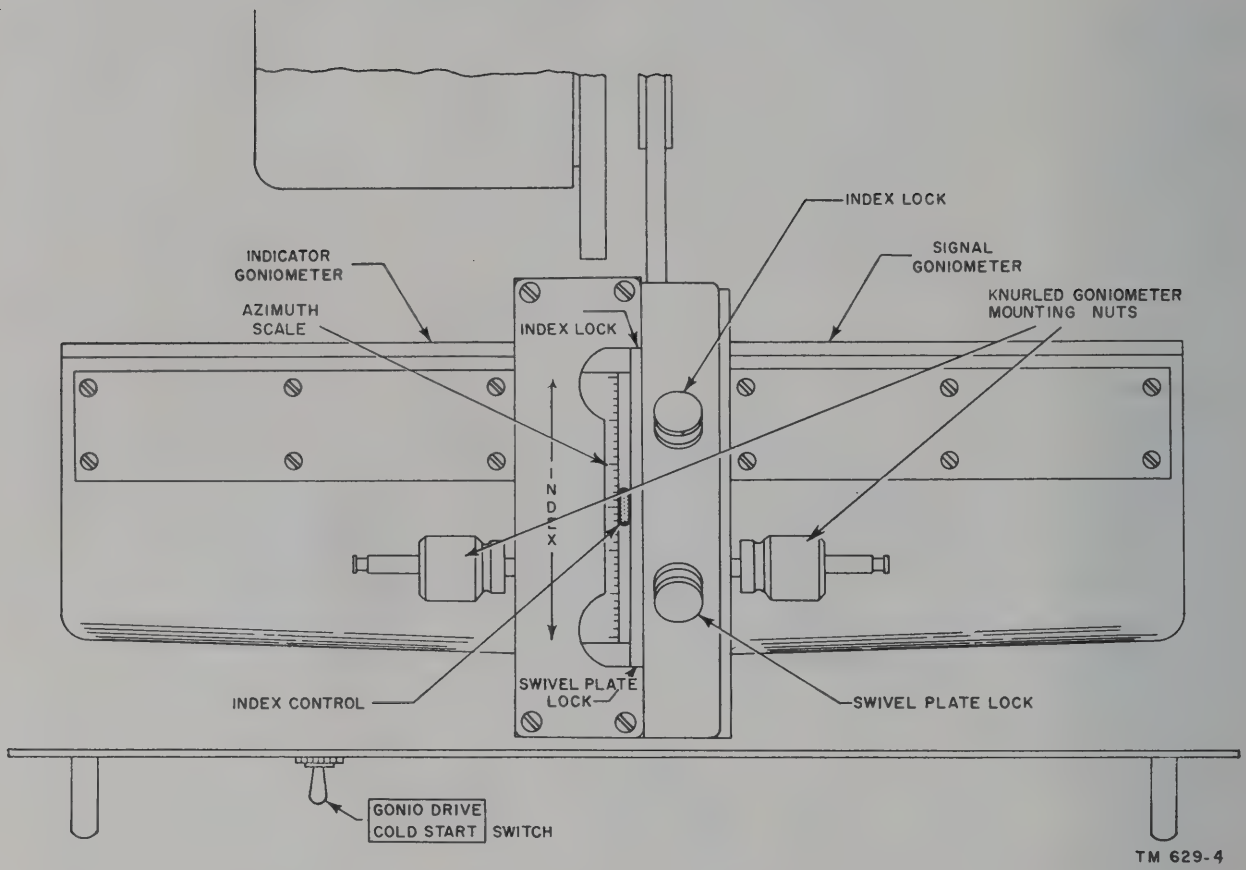

Figure 33. Goniometer Drive MX–1170/GRD, controls.

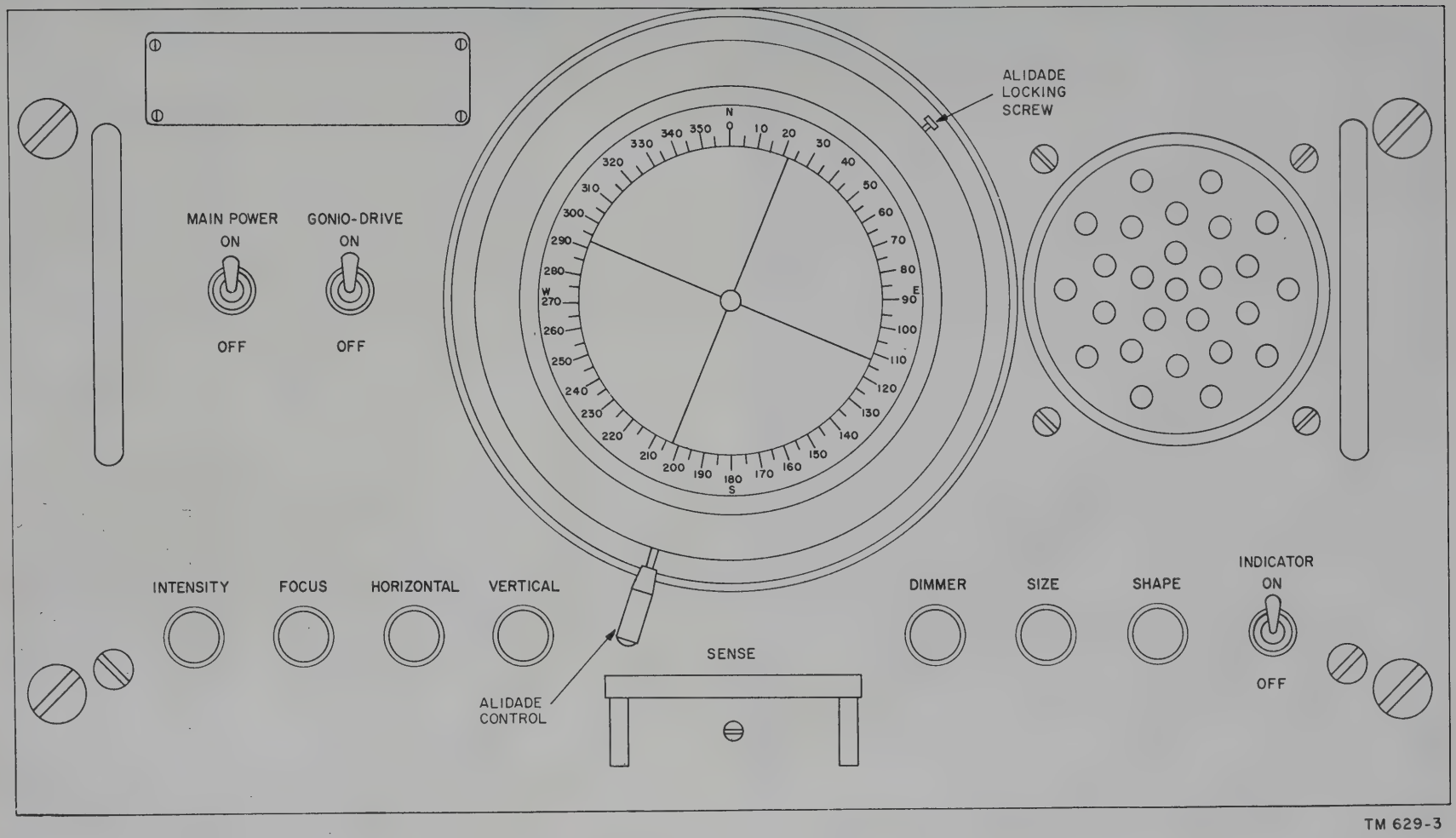

Figure 34. Azimuth Indicator IP–137/GRD, controls.

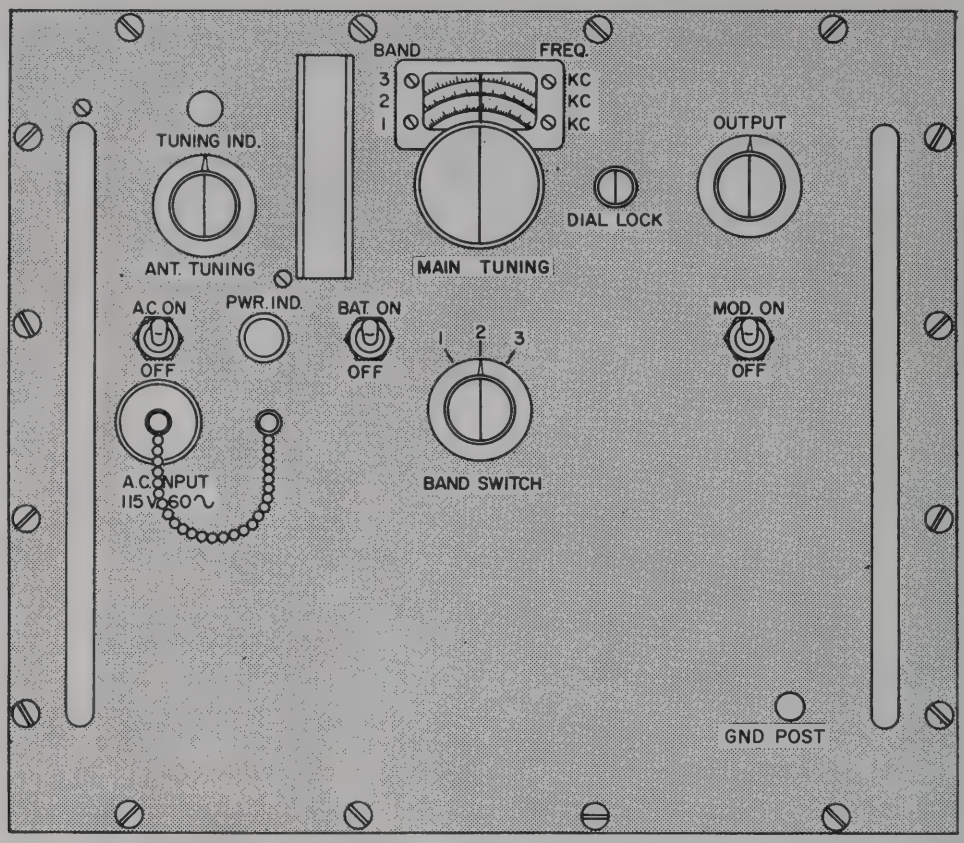

Figure 35. Radio Transmitter T–339/UR, controls.

Section II. OPERATION

51. General

a. The direction finder set has two types of operation—*visual* determination of bearing and *aural* determination of bearing. The visual system displays the bearing on a cathode-ray oscilloscope, and the aural system delivers a varying signal into a loudspeaker, with signal direction indicated by the point of lowest signal level. Both systems operate in conjunction with calibrated scale, indicating directions from 0° to 360°. The visual scale is around the outside edge of the cathode-ray tube screen, and the aural scale is the azimuth scale on the goniometer drive. During visual operation, the bearing is read by splitting the pattern developed on the cathode-ray tube screen by means of crossed hairs (the alidade). Bearings may also be taken from the azimuth scale (when rotated by hand during aural operation) by reading the bearing opposite the index of the scale on the goniometer drive.

b. Either type of operation may be used in taking bearings. The visual method is faster; however, the aural-null method is used when the visual method is unreliable because of propagation or operational reasons. Either type may be used to verify bearings obtained by the other. When bearings are swinging excessively on the visual presentation, the aural-null method will furnish reliable bearings if sufficient care is used. When signals are crowded and weak, it is best to use the aural-null method.

Caution: When the Adcock antennas are used for monitoring, turn the GONIO-DRIVE switch on the azimuth indicator to the OFF position. This will increase considerably the life of the goniometer drive motor and the goniometers. However, the goniometers should not be stopped in a position that will provide a null in the azimuth sector where signal activity is anticipated; therefore, the azimuth scale on the goniometer drive should be rotated

manually until the maximum signal is obtained from the sector of interest.

52. Reliability of Ground and Sky Waves

Bearings taken from ground and sky waves can be considered reliable if the signal is readable and the fading is not excessive. If the bearing pattern (visual operation) is changing rapidly on sky wave signals, an accurate bearing can be taken by waiting for a favorable moment. Bearings taken from ground wave signals, however, are more reliable than those taken from sky wave signals. This is due mainly to the fact that ground wave signals tend to be steadier and have the least distortion. Refer to pattern interpretation (par. 55) for additional information.

53. Preliminary Starting Procedures

a. Azimuth Indicator (fig. 34).

(1) Set the MAIN POWER, GONIO-DRIVE, and INDICATOR switches to the OFF positions.

(2) Rotate the INTENSITY and FOCUS controls fully counterclockwise.

(3) Set the HORIZONTAL and VERTICAL controls at midposition.

(4) Rotate the DIMMER control fully clockwise.

(5) Rotate the SIZE control fully counterclockwise.

(6) Set the SHAPE control to midposition.

b. Radio Receiver.

(1) Set the IF BANDWIDTH to the 2 KC position.

(2) Set the LIMITER switch to 0.

(3) Set the FUNCTION switch to OFF.

(4) Rotate the LOCAL GAIN control fully counterclockwise.

(5) Set the FREQ RANGE and FREQ CHANGE controls to the proper frequency.

(6) Set the BFO OFF-ON switch to OFF.

(7) Set the RF GAIN to 0.

(8) Set the BFO PITCH to 0.

(9) Set the BREAK IN relay to OFF.

c. Goniometer Drive. On the signal goniometer, set the SENSE switch to ADCOCK position. The SENSE switch should always remain in the ADCOCK position when used in Direction Finder Set AN/TRD–3.

d. Antenna Couplers. Set the range switch on the antenna couplers to the proper position. There is one of these switches at the base of each antenna.

e. Junction Box J–95B/CRD–2 (fig. 32). Place the LINE INPUT switch to the 115V position. Throw the OUTPUT LOAD switch to DUMMY.

54. Starting Procedure for Visual Operation

a. Power Unit PU–58/G. Check the fuel gage for an indication of an adequate supply of fuel. The oil level in the crankcase should be at the full mark on the bayonet gage. Check the water level in the storage battery; it should be three-eighths of an inch above the separators. Place the CIRCUIT BREAKER switch to the OFF position. Be sure that the HAND CRANKING POSITION-NORMAL OPERATING POSITION switch is in the NORMAL OPERATING POSITION. Press the START button for not more than 20 seconds; the engine should start. Allow at least 10 minutes running time before applying the load (placing the CIRCUIT BREAKER in the ON position). For complete information on the power unit, refer to TM 11–980, Power Unit PU–58/G.

b. Junction Box J–95B/CRD–2 (fig. 32).

(1) The OUTPUT VOLTAGE meter should indicate 115 volts. Adjust OUTPUT VOLTAGE control to correct reading.

(2) The LINE FREQUENCY meter will indicate approximately 60 cycles if the power source is nominally rated 60 cycles. The meter readings should not fluctuate.

(3) Set the OUTPUT LOAD switch to EQUIPMENT. There may or may not be a change in the OUTPUT VOLTAGE meter reading, depending on the regulation of the ac power source.

c. Azimuth Indicator IP–137/GRD (fig. 34).

(1) Throw the MAIN POWER switch to ON.

(2) Throw the INDICATOR switch to ON. The indicator and goniometer drive azimuth scales are now illuminated.

(3) Throw the GONIO-DRIVE switch to ON. The goniometer drive motor now rotates the azimuth scale on the goniometer drive.

d. Radio Receiver R–389/URR. Apply power to the receiver by setting the FUNCTION switch to the MGC position.

Note. After performing this procedure, allow 15 minutes for the equipment to warm up. Readjust the OUTPUT VOLTAGE control on the junction box if necessary.

e. Azimuth Indicator IP–137/GRD (fig. 34).

(1) Rotate the INTENSITY control clockwise until illumination is observed on the cathode-ray screen.

Caution: Avoid excessive brightness because it will damage the tube.

(2) Rotate the SIZE control fully counterclockwise.

(3) Rotate the FOCUS control clockwise until a sharply defined small dot is obtained.

(4) Adjust the HORIZONTAL and VERTICAL controls to center the dot.

(5) Adjust the DIMMER for comfortable azimuth scale viewing.

(6) Advance the SIZE control clockwise until the extremities of the illuminated area are just within the inner diameter of the azimuth scale.

(7) Adjust the SHAPE control to obtain a circular pattern. Readjust the SIZE control if necessary, refer to (6) above. Poor adjustment of the SHAPE control may cause inaccurate bearings.

(8) Readjust the INTENSITY control for comfortable viewing level; adjust the FOCUS control for a clearly defined circle.

f. Radio Receiver R–389/URR.

(1) Rotate the RF GAIN control clockwise. Noise modulation is noted on the circular pattern. If a strong signal is received the RF GAIN control should not be turned fully clockwise as this will result in a tiny dot on the azimuth indicator cathode-ray screen.

(2) Adjust the LOCAL GAIN for comfortable audio noise level from the speaker.

(3) Turn FREQ RANGE switch to the band that includes a strong signal of known direction.

Note. Make sure that the receiver IF BANDWIDTH switch is in the 2 KC position to avoid errors. Use only the MGC position of the FUNCTION switch for all direction finding operation. *Do not use AGC.*

(4) Adjust the FREQ CHANGE control until entire pattern size decreases, indicating excessive signal. Reduce the RF GAIN control and retune until two sides of the pattern collapse into the middle to form a propeller-type display (A, fig. 36). Adjust the FREQ CHANGE control for maximum closure of the pattern center.

g. Azimuth Indicator IP–137/GRD (fig. 34).

(1) Bisect propeller pattern with alidade crossed hairs to obtain accurate direct and reciprocal bearings.

Caution: Loosen the knurled alidade locking screw before attempting to rotate crossed hairs.

(2) Press the SENSE switch. The propeller-shaped pattern will change to a sense pattern as illustrated in A, figure 37. The direct azimuth of the received signal will be indicated by the direction of the arrowhead pattern.

h. Radio Receiver R–389/URR. Visual bearings on all types of signals and aural monitoring of mcw and am signals is obtained with the BFO switch in the OFF position. For aural monitoring of cw signals, throw the BFO switch to ON and adjust the BFO PITCH control for desired tone.

i. Antenna Coupler. The antenna coupler range switch on each antenna must be set to the position that corresponds to the operating frequency.

55. Pattern Interpretation

(figs. 36 and 37)

a. The pattern produced by a strong, vertically polarized signal should be clean, sharp, and steady. This type of pattern gives a bearing of the highest reliability. Some patterns will swing, change shape, and spin, but a careful operator can interpret them and obtain fairly reliable bearings. Patterns with ragged edges due to noise are prevalent when the received signals are weak; reliable bearings can be obtained from them. When two signals are heard simultaneously on approximately the same frequency (a weak signal under a strong one), the indicator will tend to show the bearing nearest to that of the stronger signal. If one or both of the interfering signals are keyed, three patterns may appear. Two of these bearings are reliable individual bearings, but when the signals occur simultaneously, the third pattern is a composite unreliable bearing. The individual bearings of several interfering signals usually can be determined with high reliability by using the aural-null method in conjunction with the radio receiver BFO control (par. 59).

b. The radio receiver RF GAIN control normally is set to the position that just barely closes the

bearing pattern at the center. If the pattern reduces to a dot when the SENSE switch is depressed, the RF gain should be reduced to form a readable sense pattern. Excessive RF gain results in a spike-like pattern which is too narrow. A very narrow pattern is difficult to read with accuracy when bearings are swinging.

c. Figures 36 and 37 show examples of cathode-ray tube displays for various conditions of received signals. The table (*d* below) explains the patterns with relation to the received signal.

d. After a half hour warmup, particularly on humid days, the circular pattern on some indicators may develop flat sides. If this condition exists for several hours, adjust the variable slug on the top of transformer T303 which is located on the top of the indicator chassis. First, reduce the circle ½ size with the size control, then use the alinement tool supplied to turn the slug on top of transformer T303 to give maximum size; readjust the shape and size controls for the best circle.

Figure	Signal condition
A, 36	Normal bearing pattern for strong signal.
B, 36	Normal bearing pattern for a moderately weak signal.
C, 36	Normal bearing pattern for a weak signal.
D, 36	Normal bearing pattern for an extremely weak signal.
A, 37	Sense pattern for a strong signal and medium sense voltage.
B, 37	Sense pattern for a weak signal.
C, 37	Sense pattern for a strong signal and medium sense voltage (low RF GAIN setting).
D, 37	Sense pattern for a strong signal and high sense voltage.
E, 37	Pattern for a keyed cw signal.
F, 37	Pattern for a no-signal condition at receiver input.

Note. Unless otherwise stated, the signals in the above table are continuous-wave, unkeyed signals.

56. Pattern Interpretation Chart

Type of indication	Characteristics	How or when to read bearing most effectively	Reliability and interpretations of bearings
Steady indication on a cw signal, icw signal or a modulated signal.	Sharp prpeller tips (A, fig. 37); does not swing more than 1°; no fading.	Read any time after tuning in; use cross hairs.	Very reliable.
Slightly fading or swinging indication on any signal.	Propeller tips sharp at times; when signal fades, propeller tips may get slightly round and signal may swing 3° to 6°.	Read when signal is strongest and tips are sharp; or watch swing and set cross hairs at point about which pattern is swinging.	Very reliable if read carefully; swinging is due to space-diversity effects which cause signal to fade at a different time for each antenna.
Badly fading and swinging indication on any signal.	Propeller tips sharp at times; signal fades very slowly and at the same time swings 10° or 20° or rotates very slowly; pattern almost disappears at times.	Pattern may stop for just a moment at a certain point when signal will be strongest and tips sharp; watch for these stops and set cross hair immediately. If pattern seems to stop at same bearing every time after it fades, read bearing at that point. If stopping points vary and signal is very wild, do not take a reading unless it is absolutely necessary.	Reliability depends on the experience of operator; a very slow, gradual change in polarization of the received signal causes large changes and differences in the voltages induced in the individual antennas and results in a badly swinging and rotating pattern.
Steady or slightly swinging indication on a weak signal.	Poorly defined fuzzy propeller tips (C, fig. 36).	Use cross hairs and read when signal is strongest.	Reliable if read carefully when signal is steady. (An extremely weak signal pattern is shown in D of figure 36.)
Indication with draw-in.	Two propeller-shaped patterns unequal in length whose tips are on same radial line (usually tips of shorter propeller blades are rounded).	If draw-in is steady use cross hairs as for normal indication. If draw-in varies read when signal is strongest and propeller tips are sharp.	Reliable if ready carefully and not swinging more than 7° or 8°. If more than 10 percent of patterns are drawn in, check all ground straps, cables, and connectors.
Nondirectional patterns.	Irregular circle that cannot be pulled in at center. Occurs when signal arrives straight down on antenna.	Bearings cannot be read.	

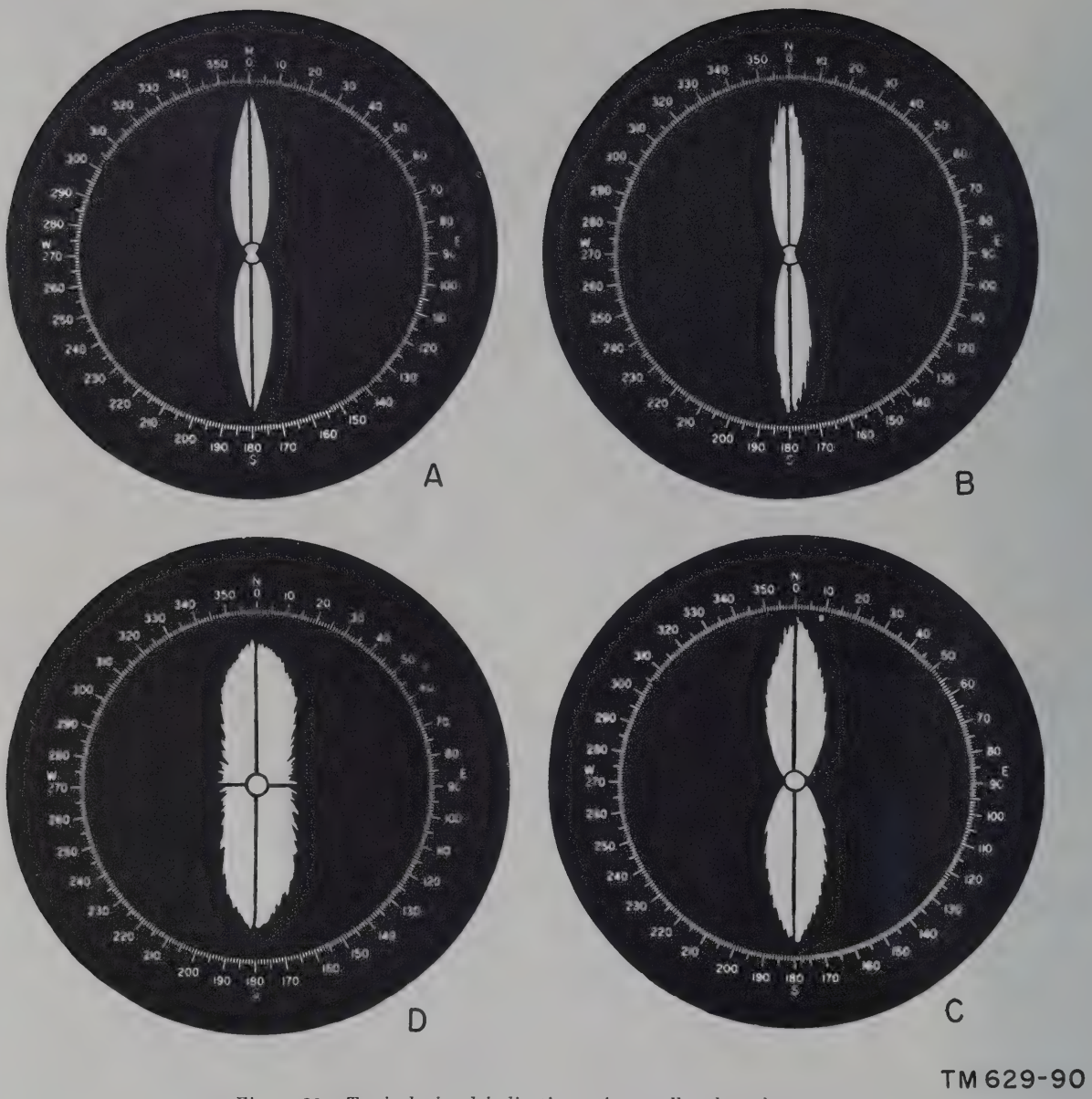

Figure 36. Typical visual indications of propeller-shaped patterns.

57. Stopping Procedure, Visual Operation

a. Standby Stopping. On Junction Box J–95B/CRD–2, throw the LINE INPUT switch to OFF.

b. Shutting Down Direction Finder Set.

(1) Turn the receiver FUNCTION switch to OFF.

(2) Turn the MAIN POWER on the azimuth indicator switch to OFF.

(3) Set the LINE INPUT and OUTPUT LOAD switches on the junction box to OFF.

(4) Shut down the power unit if it is being used by pressing the STOP button.

58. Starting Procedure, Aural Operation

For the preliminary starting procedure, apply the instructions given in paragraph 53.

a. Azimuth Indicator.

(1) Set the MAIN POWER switch to the ON position.

(2) Set the INDICATOR switch to the ON position.

b. Radio Receiver.

(1) Set the FUNCTION switch to the AGC

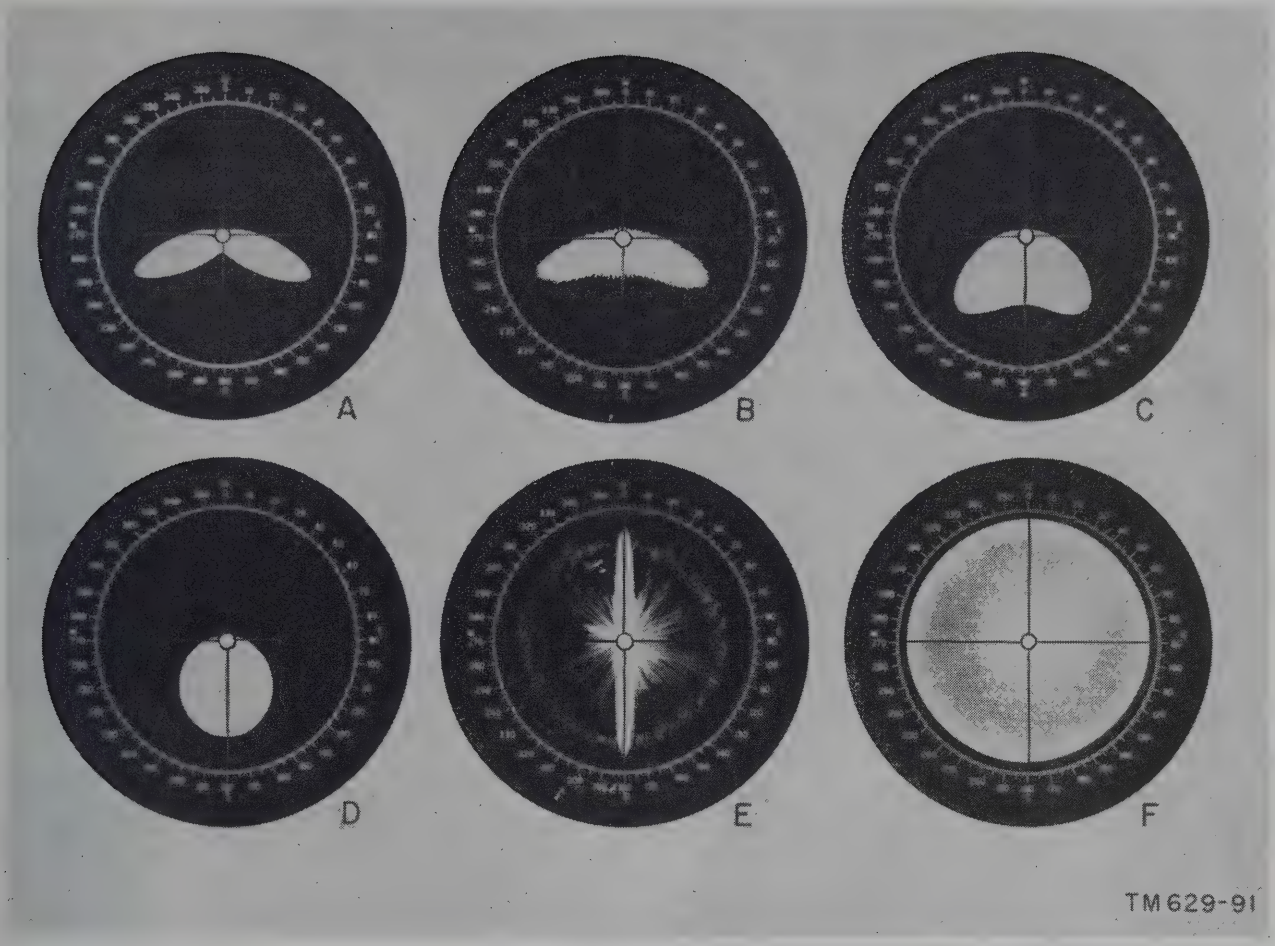

Figure 37. Typical visual indications with sense applied.

position to apply power to the receiver. Allow at least 15 minutes for warmup.

(2) Tune in a strong, steady signal of known azimuth. When the desired signal has been located, reset the FUNCTION switch to the MGC position. When finding the exact bearing of a signal, always use the MGC position; all direction finding operations must be made using the MGC position.

(3) If the signal is a cw signal, turn the BFO switch to ON. Adjust the BFO PITCH control to the desired tone.

(4) Adjust the FREQ CHANGE control for a maximum reading on the CARRIER LEVEL meter.

(5) Expose the azimuth scale on the goniometer drive by opening the cover. Rotate the scale at least 90° in either direction to determine if the scale is on a signal minimum. Readjust the receiver tuning for a maximum if necessary.

(6) Set the IF BANDWIDTH control to the position that affords the least interference. Unlike visual operation, aural operation permits using any degree of selectivity. For details of receiver operation for various conditions of interference, refer to the receiver instruction book.

c. Antenna Couplers. The antenna coupler range switch on each antenna must be set to the position which corresponds to the frequency range desired.

59. Bearing Determination, Aural Operation

The bearing null may be determined by either of two methods during aural operation. The selection of the method will depend on the conditions of signal strength, interference, and operator preference. The methods are as follows:

a. Rotate the goniometer drive azimuth scale until minimum loudspeaker (or headset) volume is obtained.

b. Rotate the goniometer drive azimuth scale until minimum CARRIER LEVEL indication is obtained on the CARRIER LEVEL meter on the receiver panel. This method is the most accurate, when the signal is positively identified.

60. Aural-Null Operation and Sense Determination

a. Obtain the null by either of the two methods given in paragraph 59. Record the reading from the white azimuth scale on the goniometer drive.

b. Depress the SENSE switch on the azimuth indicator.

c. Rotate the azimuth scale on the goniometer drive 90° in a direction that causes the white scale numbers to increase.

d. If the signal strength *decreases* while the graduations on the white scale of the goniometer drive increase, the original reading on the goniometer white azimuth scale is the correct null, and corresponds to the direction of the incoming signal.

e. If the signal strength *increases* as the white scale graduations increase; this is the reciprocal bearing. The azimuth must be read from the red scale exactly opposite the original reading on the white scale (*c* above).

61. Obtaining Aural Bearings Through Interference

Expert operation of the radio receiver will result in reliable bearings on the direction finder set when signal conditions are poor. The radio receiver manual should be read carefully before attempting operation of the direction finder set. The following is a general method of obtaining a bearing of a signal in proximity to an interfering signal.

a. Tune in the desired signal.

b. Set the BFO PITCH control of the radio receiver to zero beat with the undesired signal.

c. Obtain the bearing of the desired signal by the aural null operation described in paragraphs 59 and 79. Proper use of the receiver IF BANDWIDTH, AUDIO RESPONSE, and BFO PITCH controls, as well as the RF BANDWIDTH adjustment will help obtain reliable aural bearings when it is impossible to use the visual method.

62. Stopping Procedures, Aural Operation

a. Standby Stopping. On Junction Box J–95B/CRD–2, set the LINE INPUT switch to OFF.

b. Shutting Down Direction Finder Set.

(1) Turn the receiver FUNCTION switch to OFF.

(2) Turn the azimuth indicator MAIN POWER switch to OFF.

(3) Set the junction box LINE INPUT and OUTPUT LOAD switches to OFF.

(4) If the power unit is being used, turn it off by pressing the STOP button.

63. Starting Procedure, Target Transmitter

a. Assemble and attach the five-section antenna to the target transmitter.

b. For battery operation, throw the BAT. switch to ON. For ac operation, throw the BAT. switch to OFF and the A.C. switch to A.C. ON.

c. Set the BAND SWITCH to the desired band.

d. Adjust the MAIN TUNING dial to the desired frequency of transmission.

e. Adjust the OUTPUT control for an indication on the TUNING IND. lamp.

f. Adjust the ANT. TUNING control for maximum brilliance of the TUNING IND. lamp.

g. Apply modulation to the target transmitter by turning the MOD. switch to ON.

h. Increase the intensity of the signal by turning the OUTPUT control in a clockwise direction. This control adjusts the RF output.

i. Tune in the output signal of the target transmitter on the radio receiver, and adjust the OUTPUT control to obtain the amount of output required to identify the target signal.

Caution: Be careful not to tune the target transmitter to a frequency used by a nearby communication center. Interference to transmissions being received might result.

j. To stop the target transmitter, proceed as follows:

(1) Throw the power switch to the OFF position.

(2) Disassemble the antenna.

64. Antijamming Instructions

It is important that the direction finder operator recognizes the difference between intentional jamming and accidental interference because the deliberate application of jamming to direction finding equipment will generally be used to hide the location of important enemy positions. When the operator realizes that his equipment is being jammed, he should immediately inform his superior officer of the fact and describe the results. Under no circumstances should he cease operation.

a. Unintentional interference may result from the nearby operation of radio or radar transmitters or from power generators and other electrical equipment. The interference caused by these sources may produce effects that are similar to the effects of intentional enemy jamming and are likely to occur unless preventive measures are taken by the operator. The operator should, therefore, be familiar with these effects and be able to lessen them.

b. There are primarily two methods of jamming radio direction finders.

(1) The first method involves introducing an error into the bearing indication. This may be accomplished by the simultaneous operation of two transmitters on a common frequency from separate locations. When the enemy uses this method of jamming, the bearing will lie between the two enemy transmitters, whether aural-null or visual methods are used. By slowly varying the power radiated from one of these transmitters, the enemy can cause the apparent bearing to swing between the transmitters in a manner that is similar to the swinging and fading effects found with variations in polarization of the received signal.

(2) A second method of jamming which is particularly effective against the visual type of direction-finder equipment involves causing an additional *propeller* to appear on the cathode-ray tube or by causing the propeller indication to be masked by spurious noise on the tube.

65. Recognition of Jamming

a. Methods of jamming which introduce errors into the bearing indication are difficult to recognize since it is often characteristic of these methods that no indication of intentional jamming, other than erroneous bearings, are present. To be reasonably certain that an error has been introduced by the enemy rather than by natural sources, such as propagation conditions, equipment or power sources, the direction finder operator must be alert to unusual phenomena like abrupt changes in the indicated azimuth.

b. The direction finder operator will find that, with experience, it becomes easier to recognize the various forms of jamming which have been designed to confuse him or make it difficult to obtain a bearing on the enemy transmitter. The operator should experiment with the receiver and azimuth indicator controls in an attempt to overcome jamming when ordinary techniques fail. To obtain maximum accuracy, the operator should adhere to the following procedures.

(1) If the propeller appears normal but oscillates between two bearings, abruptly changes position, or otherwise shifts in an unconventional manner, it may be caused by two or more transmitters operating on a common frequency but separately located. The operator should record the bearings with a description of the propeller presentations and report the information to his superior officer. Under no circumstances should he cease operations. The operator should also change from visual to aural-null operation and identify the station or stations.

(2) If more than one propeller is present or the propeller rotates around on the cathode-ray tubes and a steady tone is present in the earphones or the loudspeaker, the operator should record a description of the phenomenon, notify his superior, and—

(*a*) Slowly tune the receiver frequency a little on either side of the desired signal. This practice may provide some degree

of discrimination against the propeller rotation.

(*b*) Place the receiver IF BANDWIDTH control in the 1 or .1 position and repeat the procedure in (1) above.

(*c*) Slowly reduce the RF GAIN control for optimum propeller display.

(*d*) Adjust the LIMITER control to provide optimum display on the cathode-ray tube.

(*e*) If a reasonably accurate bearing is still not obtainable, change to aural-null operation, place the BFO switch in the ON position, and vary the BFO PITCH knob until the interfering signal is eliminated or suppressed as much as possible.

CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. OPERATOR'S MAINTENANCE

66. Scope of Operator's Maintenance

The following is a list of maintenance duties normally performed by the operator of the direction finder set.

a. Performs preventive maintenance (par. 67).

b. Checks equipment by using equipment performance checklist (par. 74).

c. Replaces defective pilot lamps.

d. Replaces defective fuses.

e. Checks cable connections (par. 40).

67. Preventive Maintenance

DA Form 11-238 (fig. 38) is a preventive maintenance checklist to be used by the operator. Items not applicable to the direction finder are lined out in the figure. Instructions for the use of the form appear on the back of the form.

68. Visual Inspection

a. When the equipment fails to perform properly, turn off the power and check all the items listed below. *Do not check any item with the power on.*

(1) Disconnected or poorly connected power or RF cables (par. 40).

(2) Wrong settings of switches and controls. The operator must remember to set the switch on the antenna couplers (four switches, one on each antenna mast) for the proper frequency range (par. 49).

b. If the above checks do not locate the trouble, troubleshooting and repair at a higher echelon is necessary.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
DIRECTION FINDER SET AN/TRD-3	49

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals and accessories).~~		✓	✓				
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE, HEADSETS, CHESTSETS, KEYS~~, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.		✓	✓				
4	~~INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND REGISTORS.~~							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, ~~EXCESSIVE~~ LOOSENESS, ~~WORN OR CHIPPED GEARS, MISALIGNMENT~~, POSITIVE ACTION.		✓	✓				
6	CHECK FOR NORMAL OPERATION.		✓	✓				

WEEKLY

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS.	✓	13	INSPECT ~~STORAGE~~ BATTERIES FOR DIRT, LOOSE TERMINALS, ~~ELECTROLYTE LEVEL AND SPECIFIC GRAVITY~~, AND DAMAGED CASES.	✓
8	INSPECT CASES, MOUNTINGS, ANTENNAS, ~~TOWERS~~, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	✓	14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	✓
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	✓	15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	✓
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, ~~DAMAGED INSULATORS AND REFLECTORS~~.	✓	16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.	✓
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	✓	17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	✓
12	~~INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, POWER STATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES~~.		18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE~~.	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 1 DEC 50, WHICH IS OBSOLETE.

TM629-17

Figure 38. DA Form 11-238.

Section II. UNIT REPAIRMAN'S MAINTENANCE

69. Scope of Unit Repairman's Maintenance

Following is a list of maintenance duties performed by the unit repairman. The scope of these instructions has been determined by the available tools, materials, test equipment, spare parts, and the MOS of the unit repairman.

a. Replaces defective tubes and fuses.

b. Performs preventive maintenance (par. 71).

c. Lubricates the equipment as described in paragraph 72.

d. Performs visual inspection (par. 68).

70. Tools, Materials, and Test Equipment Required

The tools, materials, and test equipment required for unit repairman's maintenance are listed below.

a. Tools.

Tool Equipment TE–41.

b. Materials.

Paint.
Antistatic Wax.
Sandpaper No. 000.
Cleaning Compound (Federal stock No. 7930–395–9542).

c. Test Equipment.

Electron Tube Test Set TV–7/U.
Multimeter TS–297/U.

71. Unit Repairman's Preventive Maintenance

DA Form 11–239 (fig. 39) is a preventive maintenance checklist to be used by the unit repairman. Instructions for the use of the form appear on the back of the form.

72. Lubrication

The goniometer drive is permanently lubricated by the manufacturer. The azimuth indicator and junction box require no lubrication. Instructions for lubricating the receiver, shelter, and power unit are found in their respective technical manuals that are listed in paragraph 1*b*.

73. Troubleshooting By Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 74) will help the unit repairman to locate trouble in the equipment. The list gives the item to be checked, the conditions under which the item is checked, the normal indications for correct operation, and the corrective measures the unit repairman can take. *To use this list, follow the items in numerical sequence.*

b. Action or Condition. For some items, the information given in the action or condition column consists of various switch and control settings under which the item is to be checked. For other items, it represents an action that must be taken to check the normal indication given in the normal indications column.

c. Normal Indications. Normal indications listed include the visible and audible signs that the operator should perceive when he checks the items. If the indications are not normal, the unit repairman should apply the recommended corrective measures.

d. Corrective Measures. The corrective measures listed are those the unit repairman can make without turning in the equipment for field or depot level repairs. A reference in the table to a particular paragraph indicates that the trouble cannot be corrected during operation and that troubleshooting by a qualified repairman is necessary. If the set is completely inoperative or if the recommended corrective measures do not yield results, troubleshooting at field or depot level is necessary. However, if the tactical situation requires that communication be maintained and if the set is not completely inoperative, the operator must maintain the set in operation as long as it is possible to do so.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS.—See other side

EQUIPMENT NOMENCLATURE: DIRECTION FINDER SET AN/TRD-3

EQUIPMENT SERIAL NO.: 49

LEGEND FOR MARKING CONDITIONS: ✓ *Satisfactory;* X *Adjustment, repair, or replacement required;* ⊗ *Defect corrected.*

NOTE: *Strike out items not applicable.*

NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals, and accessories).~~	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, ~~MICROPHONE, HEADSETS, CHESTSETS,~~ KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS.	✓
4	~~INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS, AND RESISTORS.~~	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, ~~EXCESSIVE~~ LOOSENESS, ~~WORN OR CHIPPED GEARS~~, MISALINEMENT, POSITIVE ACTION.	✓
6	CHECK FOR NORMAL OPERATION.	✓
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, ~~WAVE GUIDES~~, AND CABLE CONNECTIONS.	✓
8	INSPECT CASES, MOUNTINGS, ANTENNAS, ~~TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	✓
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN.	✓
10	INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, ~~DAMAGED INSULATORS, AND REFLECTORS.~~	✓
11	INSPECT CANVAS ITEMS, LEATHER, AND CABLING FOR MILDEW, TEARS, AND FRAYING.	✓
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWERSTATS~~, RELAYS, ~~SELSYNS, MOTORS, BLOWERS~~, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES.	✓
13	INSPECT ~~STORAGE~~ BATTERIES FOR DIRT, LOOSE TERMINALS, ~~ELECTROLYTE LEVEL AND SPECIFIC GRAVITY~~, AND DAMAGED CASES.	✓
14	CLEAN AIR FILTERS, BRASS NAMEPLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.	✓
15	INSPECT METERS FOR DAMAGED GLASS AND CASES.	✓
16	INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.	✓
17	CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.	✓
18	CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT, AND GREASE.	✓

NO.	ITEM	CONDITION
19	~~ELECTRON TUBES: INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS; INSUFFICIENT SOCKET SPRING TENSION; CLEAN DUST AND DIRT CAREFULLY; CHECK EMISSION OF RECEIVER TYPE TUBES.~~	
20	~~INSPECT FILM CUTOUTS FOR LOOSE PARTS, DIRT, MISALINEMENT, AND CORROSION.~~	
21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION.	✓
22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALINEMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS.	✓
23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, ~~MISALINEMENT OF PLATES~~, AND LOOSE MOUNTINGS.	✓
24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION, AND MOISTURE.	✓
25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT, AND LOOSE CONTACTS.	✓
26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.	✓
27	~~INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS, CRACKS, AND BREAKS.~~	
28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
29	LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.	✓
30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.~~	
31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.	✓
32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL LEAKAGE.	✓
33	BEFORE SHIPPING OR STORING—REMOVE BATTERIES.	✓
34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	✓
35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
36	~~INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.~~	
37	MOISTURE AND FUNGIPROOF.	✓

38 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-239 Replaces DA AGO Form 419, 1 Dec 50, which is obsolete. 16—64383-2

TM629-18

Figure 39. DA Form 11–239.

74. Equipment Performance Checklist

	Item No.	Unit	Item	Action or condition	Normal indications	Corrective measures
	1	Azimuth indicator.	MAIN POWER switch.	Set to OFF position.		
	2		GONIO-DRIVE switch.	Set to OFF position.		
	3		INDICATOR switch.	Set to OFF position.		
	4		INTENSITY control.	Rotate fully counter-clockwise.		
	5		FOCUS control	Rotate fully counter-clockwise.		
	6		HORIZONTAL control.	Set at mid-position.		
	7		VERTICAL control.	Set at mid-position.		
	8		DIMMER control	Rotate fully clockwise.		
	9		SIZE control	Rotate fully counter-clockwise.		
P						
R	10		SHAPE control	Set at mid-position.		
E	11	Receiver	IF BANDWIDTH KC control.	Set to 2 KC position.		
P	12		LIMITER control	Set to zero position.		
A	13		FUNCTION switch	Set to OFF position.		
R	14		LOCAL GAIN control.	Rotate fully counter-clockwise.		
A						
	15	Receiver	BFO switch	Set to OFF position.		
T						
	16		RF GAIN control.	Set to zero.		
O						
	17		BFO PITCH control.	Set to zero.		
R						
	18		BREAK IN switch.	Set to OFF position.		
Y						
	19	Signal goniometer.	SENSE switch	Set to ADCOCK position.		
	20	Junction box	OUTPUT LOAD switch.	Set to OFF position.		
	21		LINE INPUT switch.	Set to OFF position.		
	22	Power unit		Check for adequate fuel, oil, cooling water and battery water.	Oil level should be at the full mark on the bayonet gage. Water in the battery should be $\frac{3}{8}$ inch above separators.	
	23		CIRCUIT BREAKER switch.	Set to OFF position.		
	24		HAND CRANKING POSITION-NORMAL OPERATING POSITION switch.	Set to NORMAL OPERATING POSITION.		

	Item No.	Unit	Item	Action or condition	Normal indications	Corrective measures
	25	Power unit	START button	Press (20 seconds maximum).	Engine should start. Allow 10 minute warmup.	Refer to TM 11–980 for service instruction.
	26	Junction box	OUTPUT LOAD switch.	Set to DUMMY position.		
	27		LINE INPUT switch.	Set to 115V position.	OUTPUT VOLTAGE meter should indicate 115V.	Adjust OUTPUT VOLTAGE CONTROL to obtain correct reading. If 115 volts cannot be obtained, check power unit. (TM 11–980).
S T A R T					LINE FREQUENCY meter should indicate approximately 60 cycles.	Higher echelon repair necessary.
	28		OUTPUT LOAD switch.	Set to EQUIPMENT position.	OUTPUT VOLTAGE meter reading may change slightly.	Readjust OUTPUT VOLTAGE CONTROL.
	29	Azimuth indicator.	MAIN POWER switch.	Set to ON position.	None.	
	30	Azimuth indicator.	INDICATOR switch.	Set to ON position.	Indicator and goniometer drive azimuth scales should illuminate.	Check fuse F302. Replace fuses.
	31	Receiver	FUNCTION switch.	Set to STAND-BY position.	Receiver dial will be illuminated. Allow 15 minute warmup before proceeding.	Check fuses at rear of receiver. Check power cord and connectors. Refer to TM 11–855.
	32	Goniometer drive.	GONIO-DRIVE switch.	Set to ON position.	Goniometer drive azimuth scale should rotate rapidly (approximately 1,620 rpm).	Check F301. Check cables and connectors.
E Q U I P M E N T P E R F O R M A N C E	33	Azimuth indicator.	INTENSITY control.	Rotate clockwise.	Illumination should be observed on indicator screen.	If no illumination is observed check if filament of V310 is glowing. Check V308 for glow. Higher echelon repair necessary.
	34		FOCUS control	Adjust while observing indicator screen.	Illumination on indicator screen should change to a dot.	Higher echelon repair necessary.
	35	Azimuth indicator.	HORIZONTAL and VERTICAL controls.	Adjust while observing indicator screen.	Dot should change position. Adjust as necessary to center dot.	Higher echelon repair required.
	36		DIMMER control.	Adjust while observing indicator screen.	Screen edge illumination should decrease and lightning should be uniform over the azimuth scale.	Check lamps E301 through E306. Replace if defective.
	37		SIZE control	Adjust while observing indicator screen.	Pattern should increase to a circle.	Check tubes V302 and V303. Check cable connections between indicator goniometer and azimuth indicator for loose connections (figs. 29 and 31).

	Item No.	Unit	Item	Action or condition	Normal indications	Corrective measures
	38		SHAPE control	Adjust while observing indicator screen.	Pattern should change shape. Adjust for a circular pattern. Readjust INTENSITY control for a pattern having a comfortable viewing level.	Higher echelon repair is necessary.
	39	Receiver	FUNCTION switch.	Set to MGC position.	None.	
E	40		RF GAIN control.	Rotate clockwise while observing indicator screen.	Noise modulation pattern should appear around edge of indicator screen pattern. If receiver is tuned to a station, a propeller-like pattern will appear.	Check cable connections from receiver to azimuth indicator, receiver to signal goniometer and signal goniometer to adcock antenna (fig. 29). Refer to TM 11–855. Check tubes V301 and V302. Higher echelon repair is necessary.
Q						
U						
I						
P						
M						
E	41		LOCAL GAIN control.	Rotate clockwise.	Noise or signals should be audible. Adjust for comfortable volume level.	Check connections of cable W818. Higher echelon. Refer to TM 11–855.
N						
T	42		FREQ RANGE switch.	Turn to band which includes desired frequency.	None.	
P						
E			When desired signal is an am signal			
R	43	Receiver	BFO switch	Set to OFF position.		
F	44		FREQ CHANGE control.	Set to desired frequency.	Pattern should change to propeller shape.	See item No. 40.
O						
R			When desired signal is a cw signal			
M	45		BFO switch	Set to ON position.	If receiver is tuned to a signal (item No. 44), a beat note should be heard.	Refer to TM 11–855.
A						
N	46		BFO PITCH	Rotate to produce desired audible pitch.	Pitch should vary as control is rotated.	Refer to TM 11–855.
C	47		RF GAIN control.	Adjust while observing indicator screen.	Pattern should change shape as control is rotated. Adjust for a propeller-shaped pattern as shown in A, figure 36.	Recheck setting of FREQ CHANGE control, item No. 44. Check tube V304. Refer to TM 11–855.
E	48	Azimuth indicator.	SENSE switch	Depress.	Pattern shape should change to arrowhead, as shown in A, figure 37.	Check sense relay cable W817 (figs. 29 and 31). Higher echelon repair is necessary.
	49	Target transmitter.	BAT. ON-OFF switch.	Set to BAT. ON position.	PWR. IND. lamp should light.	Check batteries. Higher echelon repair is necessary.

	Item No.	Unit	Item	Action or condition	Normal indications	Corrective measures
	50		BAND SWITCH	Set to position which includes desired frequency.	None.	
E						
Q						
U	51		MAIN TUNING control.	Rotate to set BAND FREQ. dial at desired frequency. Unlock dial before rotating and relock when dial is set.	None.	
I						
P						
M						
E						
N						
T						
P						
E	52		OUTPUT control	Rotate while observing TUNING IND. lamp.	Lamp should vary in brilliance. Set OUTPUT control for slight glow.	Check tubes V601 and V602. Higher echelon repair is necessary.
R						
F						
O						
R	53		ANT. TUNING	Rotate while observing TUNING IND. lamp.	Lamp should vary in brilliance. Set ANT. TUNING control for maximum brilliance.	
M						
A						
N						
C	54	Target transmitter.	MOD. ON-OFF switch.	Set to MOD. ON position.	Audible tone should be heard if a receiver is tuned to the target transmitter frequency.	Check tube V603. Higher echelon repair is necessary.
E						
	55	Azimuth indicator.	MAIN POWER switch.	Set to OFF position.	All panel lamps should extinguish and goniometer drive motor should stop.	
S	56	Goniometer drive.	GONIO-DRIVE switch.	Set to OFF position.		
T	57	Azimuth indicator	INDICATOR switch.	Set to OFF position.		
O	58	Junction box	LINE INPUT switch.	Set to OFF position.		
P	59		OUTPUT LOAD switch.	Set to OFF position.		
	60	Receiver	FUNCTION	Set to OFF position.		
	61	Power unit	STOP button	Depress.	Engine should stop.	Refer to TM 11–980.

75. Tube Testing Techniques

When trouble occurs, check all cabling, connections and setting of controls before removing any tubes. Try to insolate the trouble to a component or stage. If tube failure is suspected, use the procedure below to check the tubes.

Caution: Do not rock or rotate a tube when removing it from a socket. Pull it straight out with a tube puller.

a. Use of Tube Tester. Remove and test one tube at a time. Discard a tube only if its defect is obvious, or if the tube tester shows it to be defective. Do not discard a tube that tests at or near its minimum test limit on the tube tester. Put back the original tube, or insert a new one if required before testing the next one.

b. Tube Substitution Method. Replace a suspected tube with a new tube. If the equipment remains inoperative, remove the new tube and put back the original tube. Repeat this procedure with each tube until the defective tube is located.

76. Interchangeable Tubes

The older type tubes listed in the first column of the chart below can be used interchangeably with the corresponding preferred type tube listed in the second column. The third column lists the stage or stages in which the tubes can be used interchangeably. The older type tubes should be used until stocks are exhausted.

Preferred tube	Where used	Nonpreferred tube
5Y3WGTA	Rectifier V604 in Radio Transmitter T–399/UR.	5Y3WGT
5R4WGA	Rectifier V305 in Azimuth Indicator IP–137/GRD.	5R4WGY

CHAPTER 5

THEORY

Section I. GENERAL

77. General

This chapter covers the theory of Direction Finder Set AN/TRD–3. The individual components, except those components covered by individual technical manuals (par. 1*b*), are discussed in detail. Partial schematic diagrams are included to aid in understanding the theory. In the back of this manual are complete schematic diagrams of all components. These diagrams should be referred to as supplementary information for this chapter.

78. Radio Direction Finding Fundamentals

A single radio direction finder set is used primarily to determine the bearing of a received signal. Two or more direction finder sets must be used to determine the position of the transmitting station. Combining the bearings obtained by two or more direction finder sets is called obtaining a fix by triangulation (fig. 6). The ability of a radio directions finder set to determine the bearing of the received signal is determined specifically by its antenna system. There are several types of direction finding antenna systems in common use. The system used with Direction Finder Set AN/TRD–3 is called the *crossed Adcock array.*

a. Simple Direction Finding System. Figure 42 illustrates a basic radio direction finding system. The antenna system, the sense determination unit (which may be a simple vertical antenna and switch), the receiver, and the bearing indicator comprise the basic components which are found in every direction finder set.

b. Theory of Basic Direction Finding System.

(1) *Antenna array.* The antenna of the simple direction finding system may be one of several types. Small portable direction finders usually use a loop antenna. The aural (or visual) null is developed from the response pattern of the loop antenna shown in B, figure 44. Two points of minimum signal strength (nulls) 180° apart are present in a loop antenna response pattern when the broadside of the loop is perpendicular to the direction of the incoming signal. Maximum signal points (lobes) are developed when the edge of the loop is parallel to the direction of the incoming signal.

(2) *Sense unit.* In a simple direction finder set, the sense unit usually is a single vertical antenna which is switched in and out of the loop antenna circuit. More complex direction finder sets use electrical sense by various methods of sampling the signal voltages developed in the four vertical antennas of a crossed Adcock array (as in Direction Finder Set AN/TRD–3) and combining the voltages so that the result is an electrical *phantom* of a single vertical sense antenna. The response pattern of the single vertical antenna (monopole) is circular (A, fig. 44), and is combined with the figure-eight pattern of the loop antenna. The signal voltage of the sense antenna adds to one lobe of the loop antenna and subtracts from the opposite lobe. This results in the development of the cardioid pattern which has but one null and, therefore, no 180° ambiguity. Figure 45 shows the cardioid pattern resulting from application of the sense antenna.

(3) *Receiver.* The receiver selects and amplifies the desired signal from the antenna system. For aural-null operation, the audio output of the receiver is heard in a speaker or headset. If the direction finder indication system is a visual indication of the null points (a cathode-ray tube), then the IF output of the receiver is used.

(4) *Bearing indicator.* The remaining component of the basic direction finder set is the bearing indicator. This unit converts an aural or visual indication of null to a bearing in degrees. For the aural-null method, using a rotating loop antenna, the antenna itself is mechanically coupled to a scale graduated from 0° to 360°. Zero on the scale is oriented so that it corresponds to true north, and bearings are determined readily by rotating the loop, obtaining the nulls, and applying the sense circuit to eliminate the ambiguous null. For visual presentation of bearing, an electrical goniometer system is used. The antenna array, which physically remains fixed, is effectively rotated by a goniometer. The voltages developed by the incoming signal in each monopole are sampled by the rotating goniometer and are eventually displayed on a cathode-ray tube screen as a propeller-shaped pattern (fig. 36). For bearing interpretation, a circular scale graduated from 0° to 360° is placed over the cathode-ray tube with zero in the position for true north. Without sense application, the ambiguous presentation is double-lobed, with one lobe pointing to the true bearing direction, as indicated on the circular scale, and the other pointing to the reciprocal, or 180° opposed bearing direction. When sense is applied, the double-lobe pattern is shifted and distorted so that it indicates the true direction of the signal. The method used by Direction Finder Set AN/TRD–3 causes the double-lobed pattern to fold back (fig. 37), presenting an arrowhead pattern.

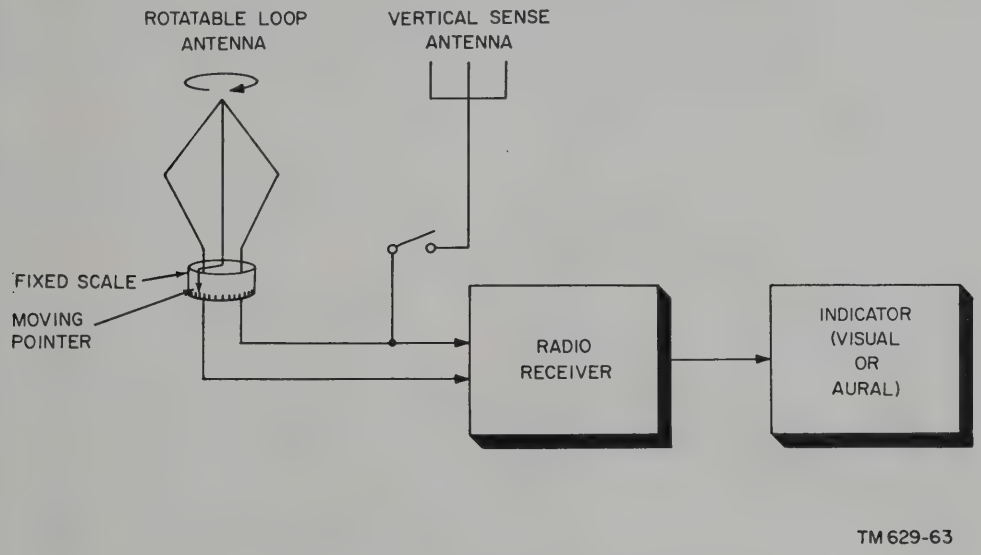

Figure 40. Basic radio direction finding system.

Section II. SYSTEM THEORY

79. General

a. Direction Finder Set AN/TRD–3 is a radio direction finder set using a fixed, oriented antenna array with an associated receiver, an azimuth indicator with both visual and aural presentation, and a rotating goniometer system. The goniometer system is used to develop a bearing-modulated wave which is changed into accurate azimuth information by the azimuth indicator. The receiver performs the functions of selecting and amplifying the weak rf energy picked up by the antenna system. The antenna array is oriented so that if a portable radio transmitter were carried in a complete circle around the array, the envelope phase at the output of the signal goniometer system would duplicate the azimuth position of the transmitter from 0° to 360°.

b. The bearing-modulated wave from the signal goniometer is amplified by the receiver and applied to circuits in the azimuth indicator. The indicator goniometer, which rotates with the signal goni-

ometer, develops a rotating line on the screen of the azimuth indicator cathode-ray tube. The strength of the signal from the signal goniometer modulates the length of the rotating line. The alternate lengthening and shortening of the rotating line produces a propeller-shaped pattern on the azimuth indicator screen. Figure 36 shows four of these patterns. The cathode-ray tube is mounted within a scale having graduations from 0° to 360° and which is supplied with a crossed-line alidade. The propeller-shaped pattern, supplying bearing information, is split by the alidade lines which indicate on the scale the bearing of the received signal.

c. The propeller-shaped pattern (*b* above) is ambiguous because it contains two possible bearings of intelligence. To eliminate the incorrect bearing, which is always 180° from the true bearing, a special circuit called the sense circuit is connected to the indicating circuits by means of a manually operated switch and a relay system. The application of the sense circuits produce a pattern as shown in A, figure 37. The interpretation of the correct bearing, therefore, is an instantanteous visual operation. The detailed operation of the sense circuit is discussed in paragraph 104.

d. For auxiliary direction finding operation, an aural-null system can be employed by using the goniometer system and the receiver in conjunction with a speaker or headset. The goniometer system can be rotated by hand and the bearing of the incoming wave is determined by observing the bearing on the goniometer drive azimuth scale index when the signal in the speaker or headset diminishes to its minimum (null) level. As with the visual system, two nulls are detectable, separated by 180°, and it is necessary to apply the sense circuit to eliminate the incorrect null.

e. To accomplish the purpose of the direction finder set, several major components are used—the antenna system, the receiver, the goniometer drive, and the azimuth indicator. The antenna system is discussed in detail in paragraph 85; other equipments are discussed in paragraphs 88 through 117. Before the circuit details of the components are presented, the discussion of the overall block diagram (fig. 41) should be understood.

80. Block Diagram

(fig. 41)

a. Radio-frequency signals intercepted by the antenna array pass through appropriate connections on the antenna coupler to the corresponding stator windings of the signal goniometer (par. 91), where they are coupled to the rotor coil. For visual presentation (fig. 42), the azimuth indicator is used. The received signal is modulated by the signal goniometer, converted by the receiver to the IF frequency, and then is coupled to IF amplifier stage V301 of the azimuth indicator. The detector stage in the azimuth indicator, consisting of diodes CR301, CR302, and CR303, rectify and filter the IF signal and shape the remaining modulation envelope. The shaped modulation envelope is coupled to control modulator V302 where it modulates the 72-kc signal from RF oscillator V309.

b. RF amplifier V303 amplifies the signal from the control modulator. From V303, the 72-kc modulated signal is coupled to the rotor of the indicator goniometer (par. 92). The indicator goniometer is connected to a common shaft and is driven at the same speed as the signal goniometer. When the modulated 72-kc signal is applied to the rotor of the indicator goniometer, the output from the stator windings furnish deflection voltage for cathode-ray tube V304.

c. SENSE switch S301 is used to eliminate the ambiguity of the propeller-shaped pattern by changing it to an arrowhead pattern which indicates true bearing.

81. Aural-Null Block Diagram

Aural-null operation (fig. 43) differs from visual operation in that the azimuth indicator and indicator goniometer are not used. The audio-frequency channel of the receiver together with a speaker or headset, is used to determine bearings by the production of audible nulls. Signals from the antenna array are passed to the signal goniometer as in visual operation; however, the signal goniometer is not rotated at high speed by the motor, but is turned slowly by hand. The receiver selects the desired signal from the signals passed through the signal goniometer and amplifies it. As the signal goniometer is rotated through 360°, two nulls, 180° apart, will be observed. The null points are detected by the signal level meter on the receiver or by ear. For sense determination, a small voltage from each antenna is added to the output of the signal goniometer by pressing the SENSE switch. This causes an increasing or decreasing signal level, depending on the direction of rotation of the signal goniometer. Refer to aural-null operation (par. 60).

ometer, develops a rotating line on the screen of the azimuth indicator cathode-ray tube. The strength of the signal from the signal goniometer modulates the length of the rotating line. The alternate lengthening and shortening of the rotating line produces a propeller-shaped pattern on the azimuth indicator screen. Figure 36 shows four of these patterns. The cathode-ray tube is mounted within a scale having graduations from 0° to 360° and which is supplied with a crossed-line alidade. The propeller-shaped pattern, supplying bearing information, is split by the alidade lines which indicate on the scale the bearing of the received signal.

c. The propeller-shaped pattern (*b* above) is ambiguous because it contains two possible bearings of intelligence. To eliminate the incorrect bearing, which is always 180° from the true bearing, a special circuit called the sense circuit is connected to the indicating circuits by means of a manually operated switch and a relay system. The application of the sense circuits produce a pattern as shown in A, figure 37. The interpretation of the correct bearing, therefore, is an instantaneous visual operation. The detailed operation of the sense circuit is discussed in paragraph 104.

d. For auxiliary direction finding operation, an aural-null system can be employed by using the goniometer system and the receiver in conjunction with a speaker or headset. The goniometer system can be rotated by hand and the bearing of the incoming wave is determined by observing the bearing on the goniometer drive azimuth scale index when the signal in the speaker or headset diminishes to its minimum (null) level. As with the visual system, two nulls are detectable, separated by 180°, and it is necessary to apply the sense circuit to eliminate the incorrect null.

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(fig. 41)

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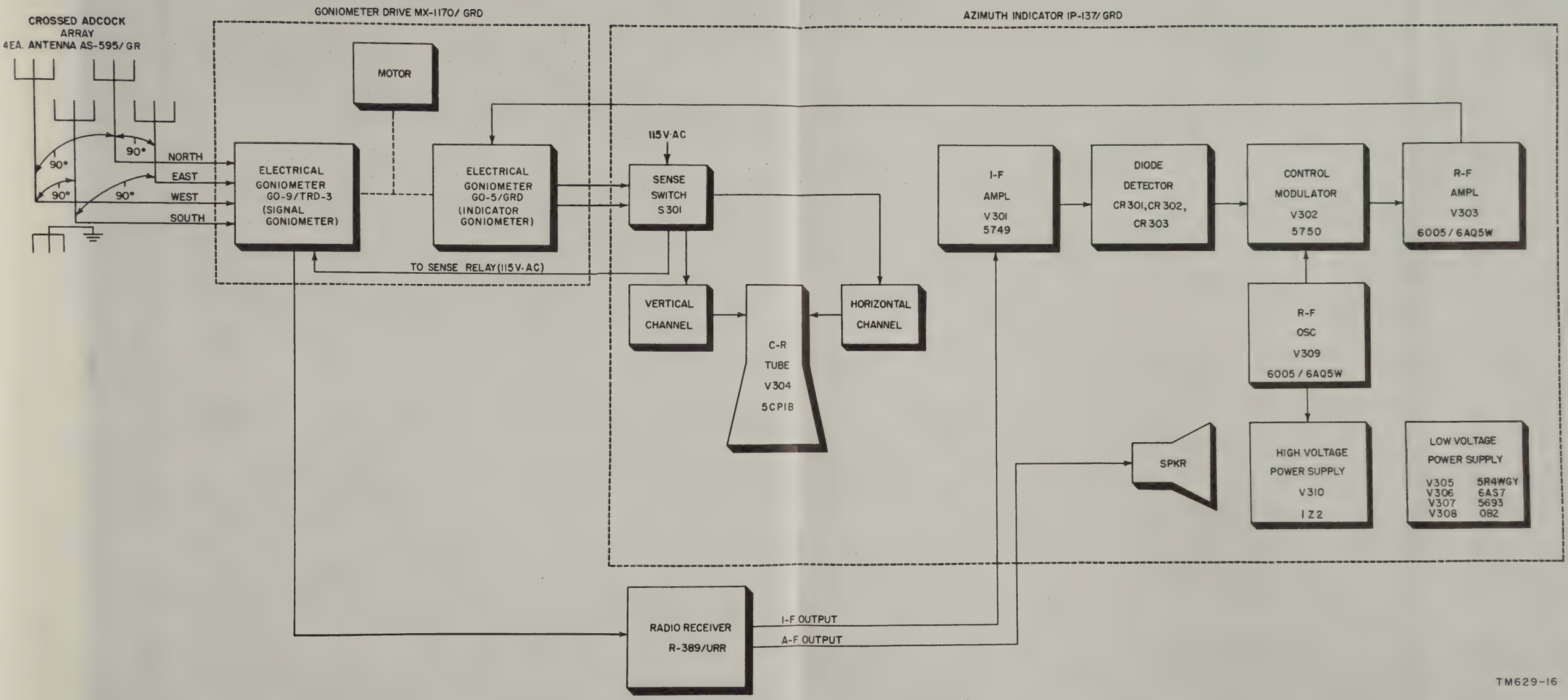
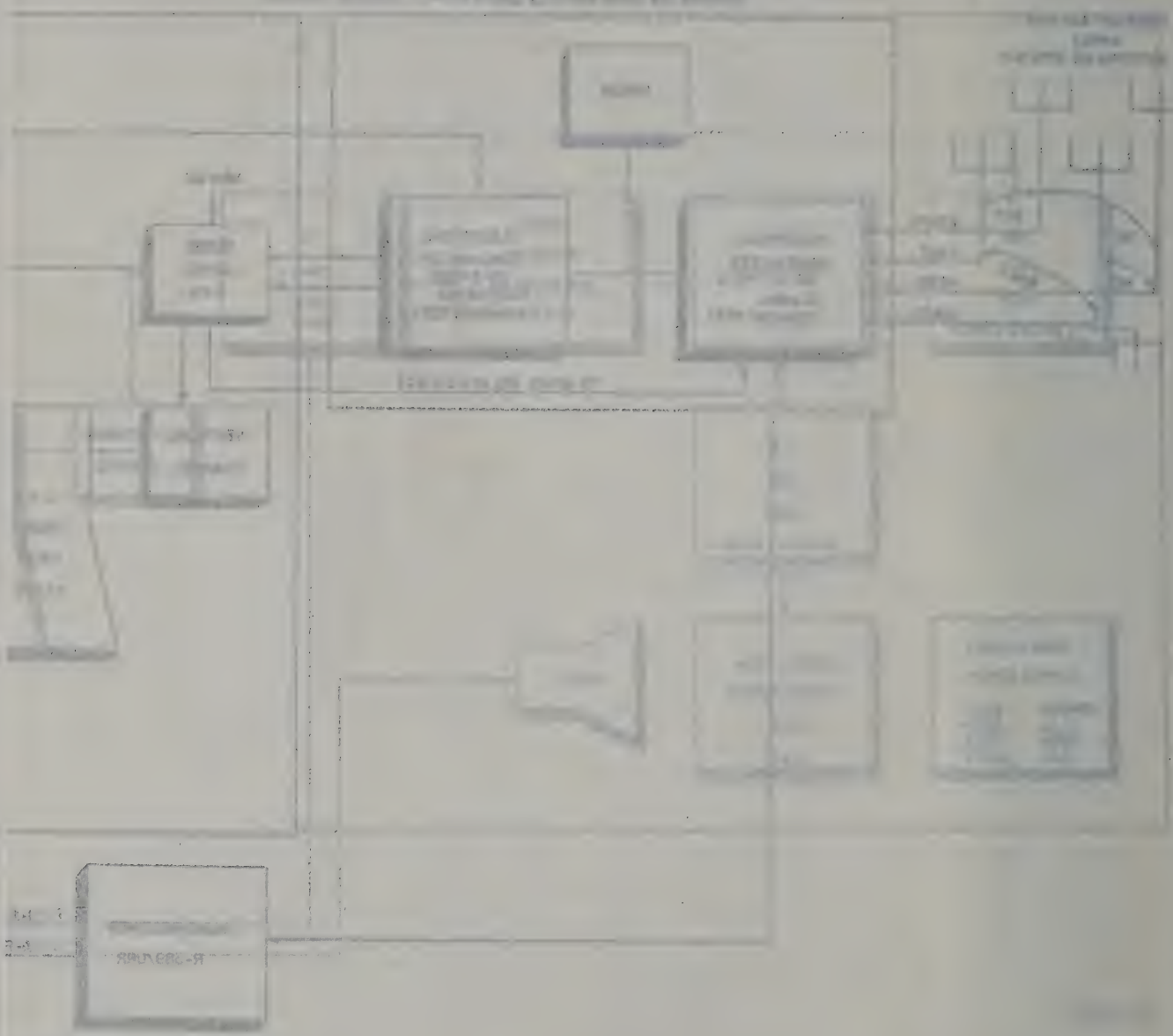


Figure 41. Direction Finder Set AN/TRD–3, block diagram.



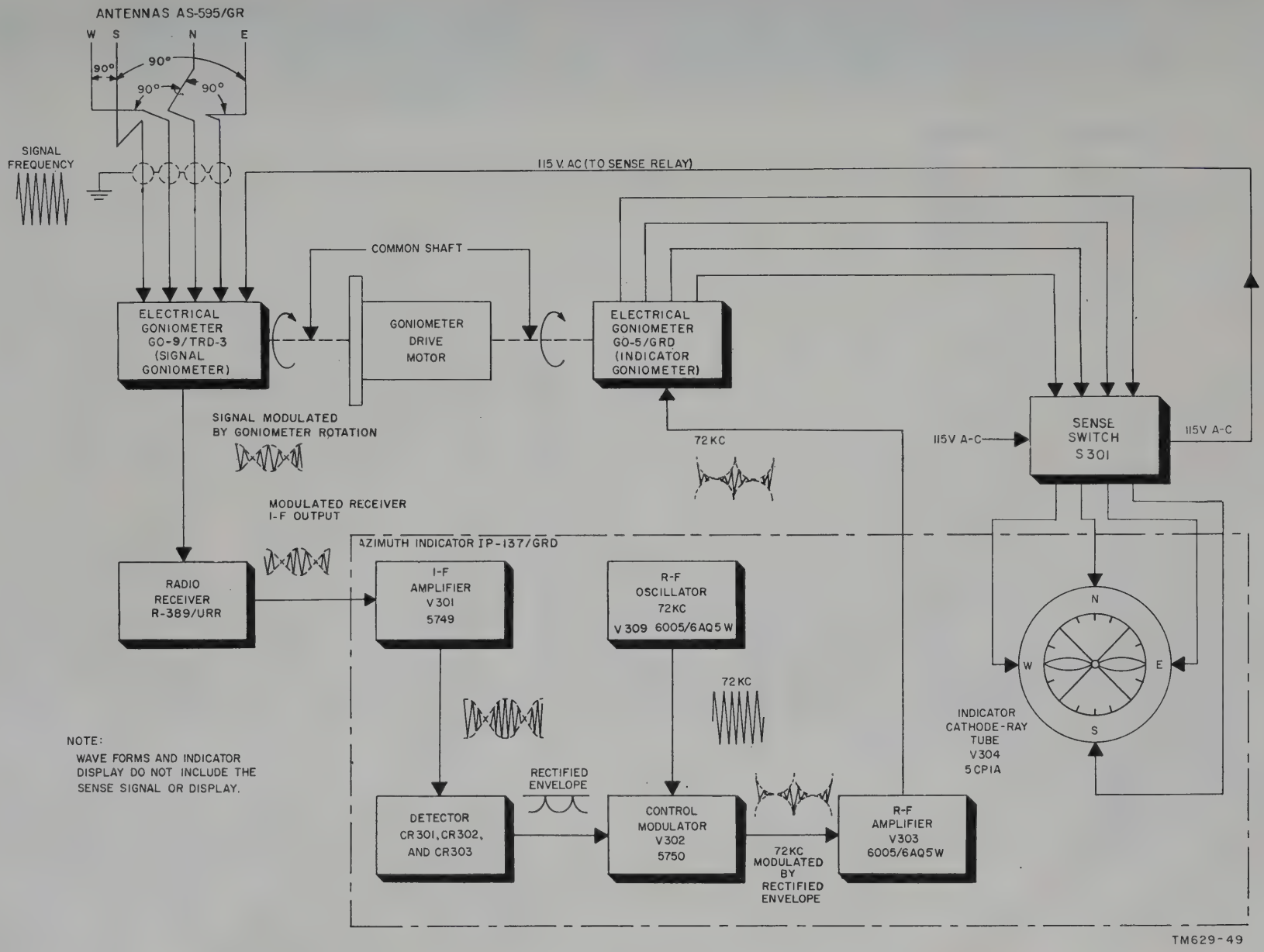


Figure 42. Visual operation, block diagram.

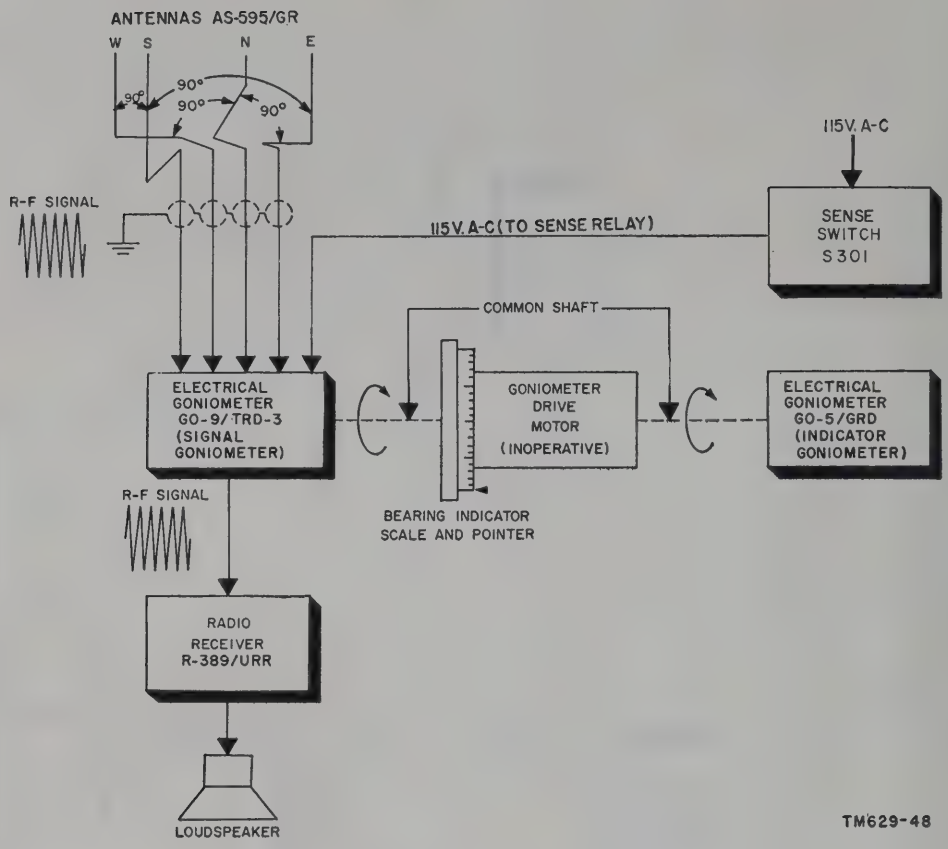


Figure 43. Aural-null operation, block diagram.

Section III. ANTENNA THEORY

82. General

Paragraphs contain the theory of the Adcock antenna system used with the direction finder set. Included is the basic antenna theory necessary for an understanding of direction finding antenna systems and their application. Propagation effects and error sources are discussed, and practical methods for their elimination or reduction are given. For detailed information relative to general antenna systems and antenna theory, refer to TM 11–666, Antennas and Radio Propagation.

83. Vertical Monopole Antenna

The horizontal dipole is the fundamental antenna for horizontally polarized radiation, and the vertical monopole is used as the fundamental antenna for vertically polarized radiation. The vertically polarized wave is used in direction finding operation. The vertical monopole receives radiation equally well in all directions, and exhibits a polar pattern as shown in A, figure 44. The horizontal response pattern of the vertical monopole depends on the received wave length, the height of the antenna, and the ground conductivity at the location of the antenna itself. In general, a monopole responds well to vertically polarized ground wave components of received radiation, and to low angle downcoming wave fronts. Such an antenna is not particularly suited for the reception of horizontally polarized waves and, in direction finder sets, a considerable error can be introduced by horizontally polarized downcoming signals. The monopole antenna is used in two ways in common direction finding systems. The monopole may be used as a sense antenna for rotating or fixed crossed loop direction finder sets, or as single elements of crossed Adcock direction finding arrays, as in the direction finder set.

84. Loop Antenna

a. To determine the direction of arrival of a received radio wave, it is necessary to use a receiving antenna system with directional character-

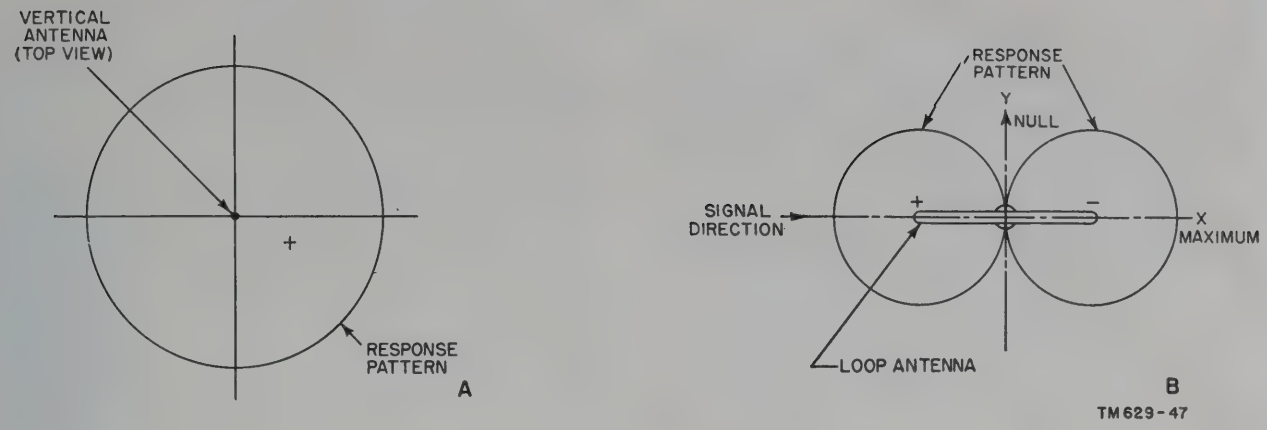


Figure 44. Response patterns of basic antennas.

istics. The response of the antenna system must depend on its orientation with respect to the direction of the arrival of the radio wave.

b. The simple loop antenna complies with this requirement. Such an antenna has a directional figure-eight response characteristic (B, fig. 44). Thus, if a small transmitter is moved about a loop receiving antenna, unequal responses will be obtained at equal transmitter distances.

(1) The output voltage of this antenna is the result of phase differences between the voltages induced in opposite sides of the antenna. Consider the case of the loop antenna placed in the path of a vertically polarized radio wave. When the broadside of the loop antenna is perpendicular to the direction of wave travel, the wave front reaches the two sides of the loop at the same time. The voltages induced in the two sides are of equal magnitude and the same phase and, being directed in opposition through the loop, cancel each other. This results in a zero output known as a *null.*

(2) As the loop antenna is rotated about a central vertical axis and brought nearer to parallel with the direction of wave travel, the wave front reaches the two sides of the loop at slightly different times. This causes a phase difference between the voltages induced in the two sides and gives rise to a resultant voltage that is maximum when the edge of the loop antenna is parallel to the direction of wave travel.

c. Since the response of the loop antenna depends on the direction of arrival of the wave front with respect to the plane of the array, the antenna response may be used to determine the azimuth of a transmitter. To do this, the antenna must be rotated to the null or zero output position. A pointer set perpendicular to the array and located at its center will indicate the line of arrival of the radio wave (fig. 40). There are two null positions, 180° apart. Either null gives the line of arrival of the wave but does not distinguish between two possible directions along the line, leaving a 180° ambiguity in the azimuth of the transmitted signal. This ambiguity may be eliminated by combining the loop antenna output with the output of a single vertical antenna. The response diagram of the combined antennas shows which antenna null corresponds to the true signal azimuth. Upon connection of the sense antenna, the response pattern becomes cardioid-shaped. Figure 45 shows the development of this cardioid response pattern.

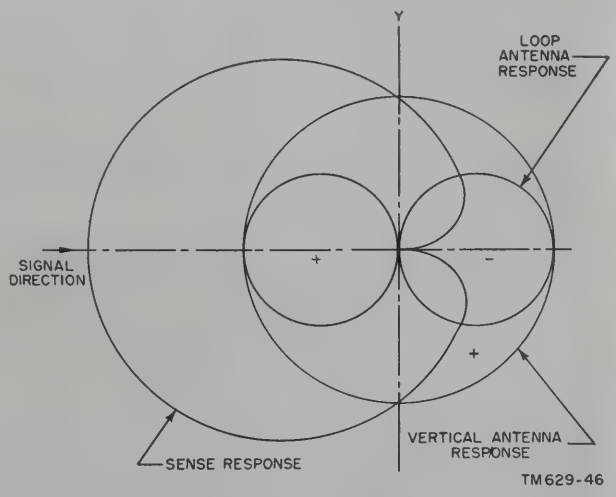


Figure 45. Development of cardioid response.

85. Adcock Antenna System

Errors associated with downcoming horizontally polarized waves cause unreliability of antenna operation in direction finding systems. The development of the Adcock antenna resulted in greater accuracy for the determination of bearings.

a. The Adcock antenna array consists of pairs of spaced, vertical dipoles connected differentially. As long as the spacing between the elements is small when compared to the wave length of reception, the directivity pattern of this antenna is a figure-eight similar to that produced by the loop antenna (fig. 44). Careful balancing of the antenna and transmission lines prevents horizontally polarized components from entering the transmission lines and, therefore, reduces polarization errors.

b. The schematic diagram of a type of Adcock array known as an H-Adcock array is shown in figure 46. This type of array must be supported a considerable distance above the ground. The sections designated *V* are vertical elements; those designated *H* are horizontal. A modification of the Adcock antenna is known as the shielded-U array. Only the upper element of each dipole is used. These upper elements are called *monopoles* and are mounted over a large ground screen called a *counterpoise*. The counterpoise acts as a mirror under the monopole. Thus, the shielded-U array is essentially an H-Adcock with the lower elements replaced by the reflections (called images) of the monopoles. Shielding of the horizontal arms minimizes horizontal pickup. The direction finder set uses two of these shielded-U arrays.

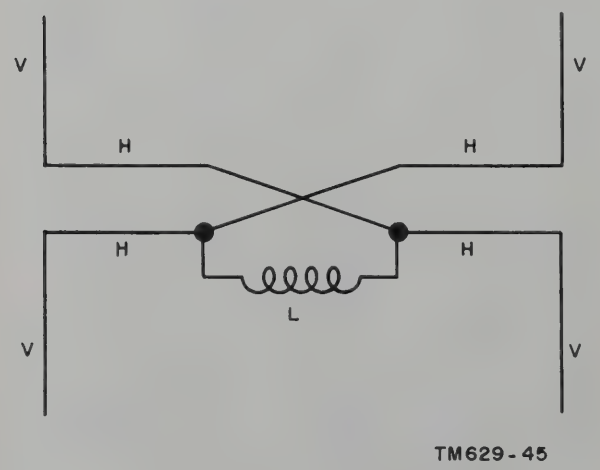


Figure 46. Basic Adcock antenna.

86. Adcock Antenna Response Pattern
(fig. 47)

The Adcock antenna array produces a figure-eight response pattern similar to that of the loop antenna, when the spacing between elements is a fraction of a wave length. Figure 47 shows the response patterns of the individual monopoles of the shielded-U type Adcock antenna array as used in the direction finder set; the sense antenna simulation is shown as a phantom vertical monopole in the center of the array. The combined voltages of all monopoles produce a circular sense response, giving the effect of a monopole in the exact center of the array.

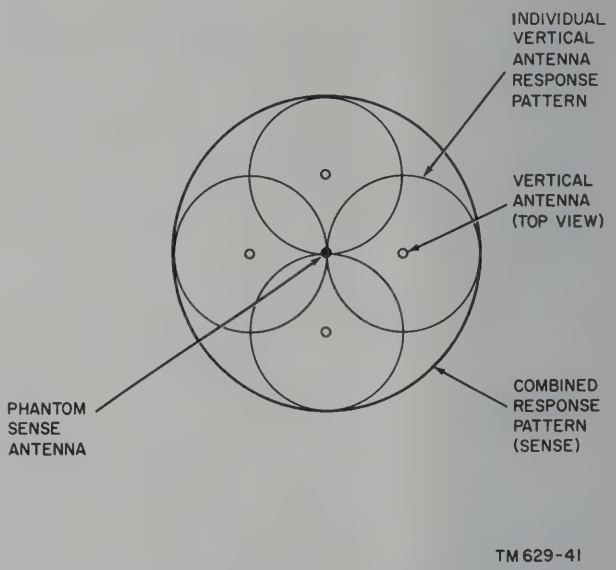


Figure 47. Adcock antenna array response pattern and development of phantom sense antenna.

87. Polarization Effects and Error Sources

The accuracy of an Adcock antenna array used for direction finding depends on the polarization (horizontal or vertical) of the RF waves with respect to the location and position of the antenna system. A number of factors will influence accuracy: path deviation, fading, absorption, and coastal refraction are some examples. They are discussed in detail in *a* through *e* below.

a. Polarization Errors. Polarization errors occur when the arriving wave is abnormally polarized with respect to the vertical polarization response of the antenna elements. Horizontally polarized waves induced in the horizontal elements (transmission lines) of the Adcock antenna system are the major

source of errors of this type. Shielding of the horizontal components of the system is successful in eliminating some of the horizontal pickup, but total elimination is impossible. Polarization errors are characterized by broad, indefinite, displaced nulls, or rounded propeller tips, depending on the type of indication used. Polarization errors also may be indicated by a sharp null but displaced enough to give an erroneous bearing. Some swinging of the bearing may be evident. If indications show that polarization errors are present, the bearings will be unreliable and should be rechecked later.

b. Lateral Deviation. When a wave is deflected from the ionosphere along a path different from the true great circle path connecting the transmitting and receiving stations, *lateral deviation* is said to exist. Such a condition is caused by tilting of the ionosphere and can result in errors as much as 4° or 5° when it is the sole source of error. Larger errors may result if lateral deviation is present with interference effects. The presence of lateral deviation is detected by a slow swinging of the bearing over a period of several minutes. The only remedy for such an error source is delaying the taking of bearings for a long period, or the taking of many bearings in a short period, and averaging the results.

c. Coastal Refraction. When a ground wave encounters an abrupt change in terrain, such as a coast line oblique to the direction of propagation, refraction may occur and cause errors as much as 4° or 5° in magnitude. The presence of this type of error is not readily detectable; it is best to avoid siting the direction finder set near coast lines or other abrupt changes of terrain (par. 18).

d. Multipath Interference. The arrival, by diverse routes, of two or more components of the same wave at the receiving antennas is known as *multipath interference.* The waves, arriving by different routes, require different transmission time and, therefore, cause either reinforcement of the original signal or a partial cancellation. The effects of this will cause a fading signal with weak presentation and an apparent shift in bearing if changes in polarization angle on one of the paths occur. This type of interference can be detected by fading signals aurally or visually, and a rapid shift in bearing or swinging of the pattern.

e. Equipment Errors. Equipment errors are of two types—those inherent in the equipment and those resulting from incorrect adjustments and faulty installations.

(1) *Quadrantal error.* The source of quadrantal error is in the equipment itself, either in the form of manufacturing tolerances or faulty adjustment. It can be improper siting of the direction finder set. An example of a quadrantal error source is incorrect placement of the masts of the Adcock antenna array, so that the system is unsymmetrical.

(2) *Site errors.* The site at which the direction finder set is installed can be a source of errors. The proximity of nearby objects such as buildings, fences, towers, and forests will introduce errors to some extent. Irregularities in ground conductivity or topography are factors that affect accuracy. The site should be carefully selected (par. 18) to avoid possible error sources. Every precaution taken in the installation of the direction finder set will help to reduce possible unbalance in the antenna system and transmission line network.

Section IV. THEORY OF GONIOMETER DRIVE MX–1170/GRD

88. General

The goniometer drive is an electromechanical assembly for turning the electrical goniometers (signal goniometer and indicator goniometer) simultaneously and at the same speed. The goniometer drive has an azimuth scale coupled to the drive mechanism for indicating the bearing of a signal when the equipment is used as an aural-null direction finder set. The schematic diagram of the goniometer drive is shown in figure 90. A block diagram of the goniometer drive as used with the goniometers is shown in figure 48.

89. Goniometer Drive Circuit

(fig. 90)

a. Motor B701 is a 1/15 horse power (hp) induction motor operating at 1,620 revolutions per minute (rpm) from a 115-volt 60-cycle ac source. The motor drives the azimuth scale and the two goniometers through a belt and pulley arrangement.

b. Capacitor C701 is used to start induction motor B701. The capacitor causes a phase shift in one of the two windings of the motor to produce a rotating field which starts the motor.

c. GONIO-DRIVE COLD START switch S701 connects C702 into the circuit to provide a heavier starting current. This switch is used only when the surrounding temperature is below zero.

d. Dial lamps E701 and E702 illuminate the azimuth scale. The 6.3-volt ac power required is supplied from a winding of the azimuth indicator power supply.

e. Connector P701 connects all the necessary circuits for the power and control of the goniometer drive. Connection of P701 to the azimuth indicator is made through the appropriate cable (par. 40).

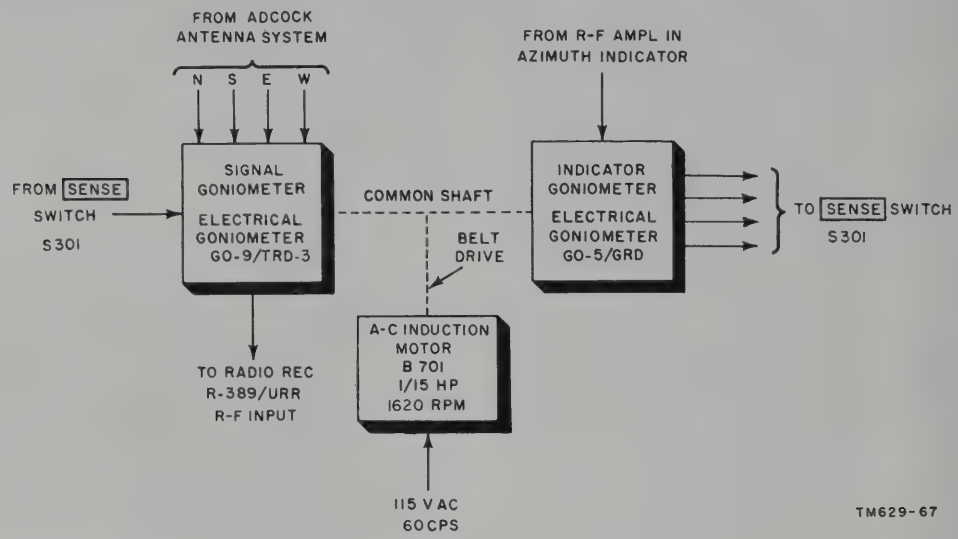


Figure 48. Goniometer drive, block diagram.

Section V. THEORY OF ELECTRICAL GONIOMETERS GO–9/TRD–3 AND GO–5/GRD

90. General

The signal goniometer and indicator goniometer are similar rotating transformers turned by the motor of the goniometer drive. Their electrical and mechanical characteristics are discussed in paragraphs 91 and 92.

91. Electrical Goniometer GO–9/TRD–3 (Signal Goniometer)

(fig. 91)

a. The stators of the signal goniometer are connected to the north-south and east-west antennas, the output of the rotor will depend on its position relative to the resultant stator field. This field, in turn, depends on the direction of arrival of the radio wave at the antennas. The result of turning the rotor in this field is to modulate the RF signal or vary the amplitude as shown in figure 49. The rotor position at which the nulls and peaks of this signal occur depends on the direction of arrival of the radio wave. The fact that there are two such nulls and peaks for each revolution causes a 180° ambiguity which requires the sense detecting system explained in paragraph 104. The signal goniometer is used to cover the range of frequencies covered by the direction finder set.

b. The output of the east-west antenna is connected to signal goniometer stator L541 through connectors J541 and J542. Resistor R545 provides a low-impedance connection to ground to prevent mutual coupling between windings and to improve the balance ratio. The north-south antenna output is applied through connectors J543 and J544 to stator L542. Resistor R546 provides a connection to ground and prevents mutual coupling in the same manner as resistor R545.

c. The rotor winding (search coil) is inductively coupled to the stator windings and its output is applied to the primary of rotary output transformer T541. The transformer secondary is connected to output connector J545.

d. Resistors R541, R542, R543, and R544 are used to obtain small equal portions of signal from each antenna for sensing. They also serve as damping

resistors to broaden the frequency response of the signal goniometer.

e. When sense relay K541 is energized, equal portions of signal from each antenna are fed to the sense injection coil through a sense phasing network consisting of resistor R547 and capacitor C543. The sense injection coil is an electrostatically shielded winding on rotary transformer T541. The sense phasing network compensates for phase shift caused by the inductance of the rotary transformer. The 115-volt ac excitation for sense relay K541 is applied through connector P541 when the sense switch is depressed. Capacitors C541 and C542 are RF bypass capacitors that keep any RF signal out of the power line.

92. Electrical Goniometer GO–5/GRD (Indicator Goniometer)

(fig. 92)

The indicator goniometer is similar to the signal goniometer discussed is paragraph 91. The coils in the indicator goniometer, however, are designed for a 72-kc signal. This signal is generated in the azimuth indicator. A sense network is included in the goniometer but is not used. The indicator goniometer converts a 72-kc signal to a two-phase signal to produce a diametral line on the azimuth indicator screen. A diametral line is a straight line across and through the center of the cathode-ray tube screen. It is the diameter of the circle formed by the screen of the cathode-ray tube (fig. 52).

a. A 72-kc input signal is applied through connector J405 to the secondary winding of rotary transformer T401. The output signal developed across the primary winding of T401 is connected directly to the rotor. The rotor is inductively coupled to stator windings L401 and L402. The output signal developed across the stator windings is fed to the deflection system of the indicator tube through connectors J401, J402, J403, and J404.

b. Paragraphs 95 through 97 explain the development of the pattern on the azimuth indicator screen.

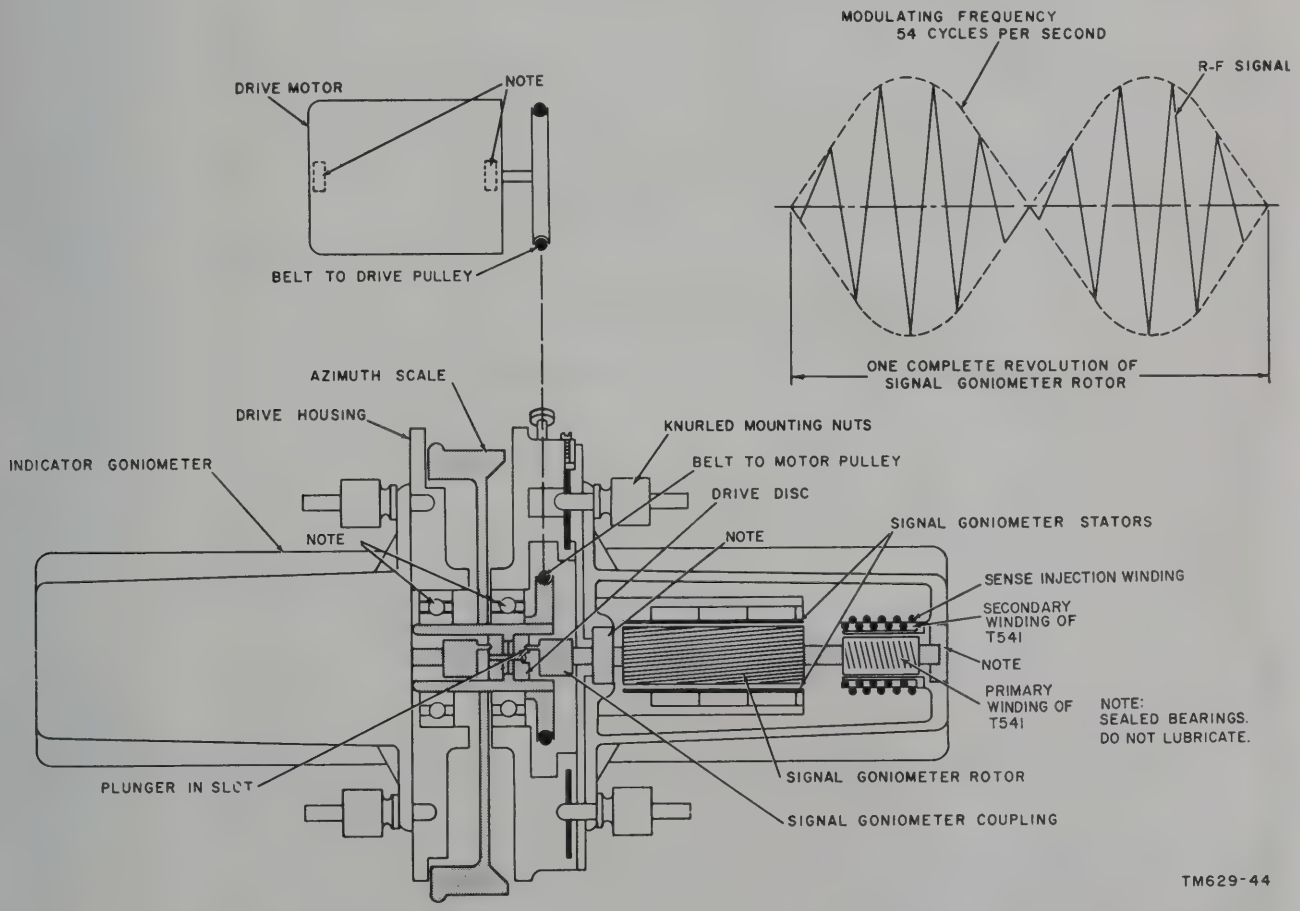


Figure 49. RF antenna signal modulated by rotation of signal goniometer and sectional view of goniometer and goniometer drive.

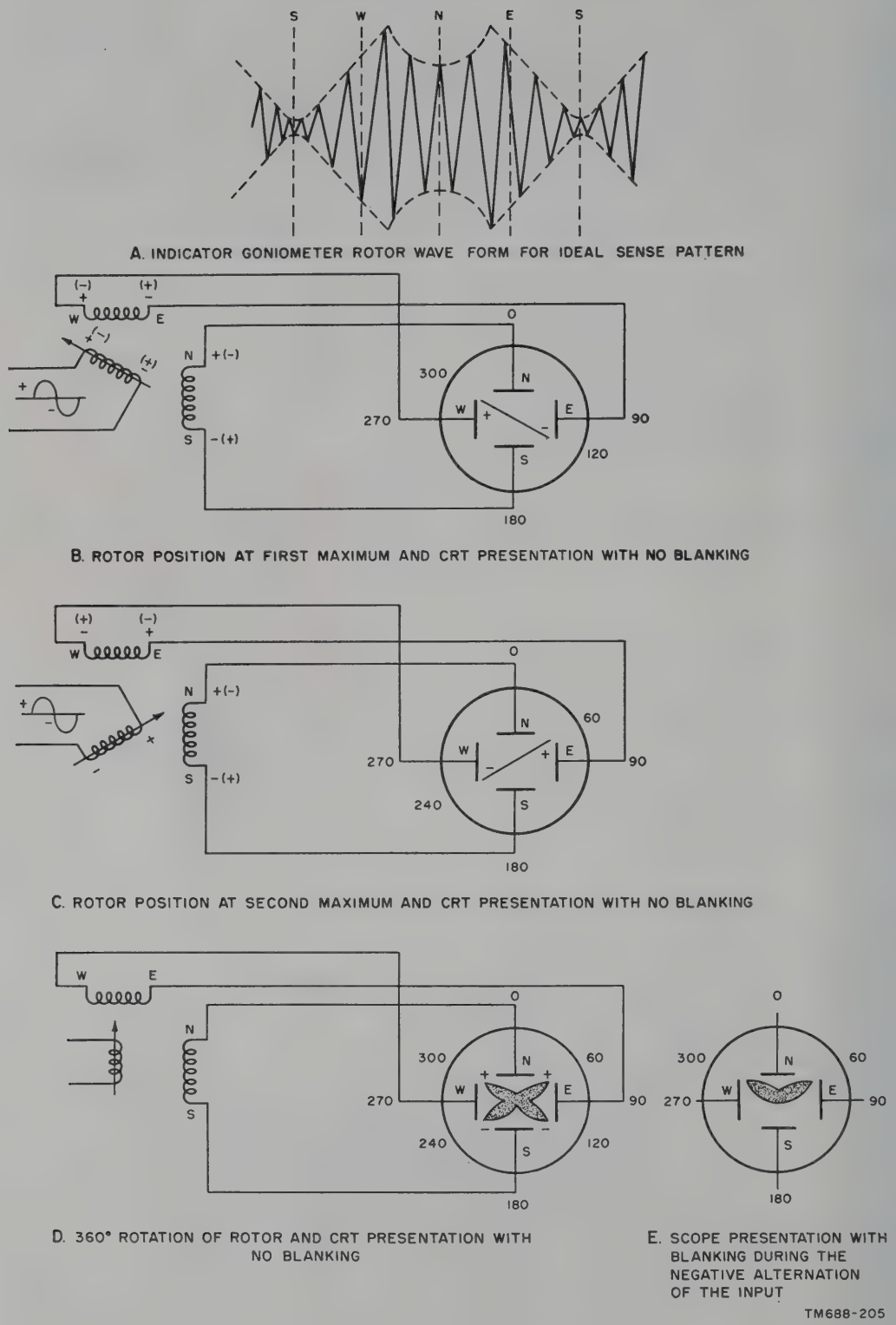


Figure 50. Development of sense pattern from signal goniometer rotor wave form.

Section VI. THEORY OF AZIMUTH INDICATOR IP–137/GRD

93. General

Azimuth Indicator IP–137/GRD utilizes a cathode-ray tube for visually indicating the direction of arrival of a radio signal. The azimuth indicator visually displays bearing information determined by the goniometer assembly. Under normal signal conditions, a propeller-shaped wave form is displayed on the cathode-ray tube screen. The bearings are obtained directly from a calibrated scale surrounding the screen. See figure 51 for a block diagram of the azimuth indicator and figure 93 for the schematic diagram.

94. Block Diagram

(fig. 51)

a. IF Amplifier. The modulated IF output signal of the receiver is fed to the azimuth indicator where the voltage level is raised by IF amplifier V301, the output of which is coupled to the detector.

b. Detector. The signal is demodulated and shaped by the detector stage.

c. RF Oscillator. The 72-kc RF voltage generated by RF oscillator V309 is coupled to the control modulator and is the basic signal source used to produce the circular no-signal pattern. An additional function of the oscillator is to provide RF excitation to a high-voltage transformer for rectification to —2,000 volts dc.

d. High-Voltage Power Supply. The output of the high-voltage transformer is rectified by V310 and applied to a filter and bleeder system to form a negative 2,000-volt supply. This supply is to provide the various cathode-ray tube potentials.

e. Control Modulator.

(1) *No-signal condition.* The 72-kc signal from oscillator V309 is applied to control modulator V302 and fed through RF amplifier V303 to the deflection plates of the cathode-ray tube. The pattern appears as a filled-in circle.

(2) *Signal condition.* The signal voltage derived from the signal goniometer is detected and applied to the control grid of control modulator V302 pentagrid converter, and a steady 72-kc signal is applied to the signal grid. The modulating frequency is approximately 54 cycles since the indicator goniometer is rotating at 27 revolutions per second, and there are *two* maximum signal positions per revolutions. The negative excursion of the modulation voltage of 0 to —3 volts varies the output of the control modulator, thus controlling the amplitude of the rotating diametral line. With the modulation wave shape shown in figure 53, a propeller-shaped pattern is obtained.

f. RF Amplifier. RF amplifier V303 increases the power level of the modulated 72-kc signal which is then applied to the horizontal and vertical channels through the indicator goniometer (par. 92).

g. Indicator Cathode-Ray Tube. A propeller pattern indicating the direction of the incoming signal is obtained on the face of cathode-ray tube V304. The position of the pattern on the face of the tube is determined by the signal from the signal goniometer which, in turn, depends on the direction of the incoming signal. An alidade assembly is used for obtaining the exact bearing of the signal.

h. Low-Voltage Power Supply.

(1) *Rectifier.* Power rectifier V305 rectifies the 50 to 60 cps ac from the power transformer to supply plate voltage for the various tubes in the azimuth indicator.

(2) *Dc amplifier V307.* Dc amplifier V307 amplifies the changes in power supply voltage produced by changing load or changing line voltage and applies a signal to the grid of regulator tube V306 to maintain a constant dc output voltage.

(3) *Regulator.* Regulator tube V306 is a variable resistance in series with the plate supply and its load. Changes in output voltage result in a compensating change in plate resistance of the regulator tube under control by the dc amplifier. The output voltage is maintained at +275 volts.

(4) *Voltage regulator.* Voltage regulator V308 is a cold cathode type gaseous voltage regulator tube. This tube provides an independent reference voltage for the dc amplifier.

95. Development of Circular Pattern

a. The 72-kc output of the oscillator is coupled to grid 3 of the control modulator, a pentagrid type 5750 (V302) (fig. 59); the amplitude of the voltage

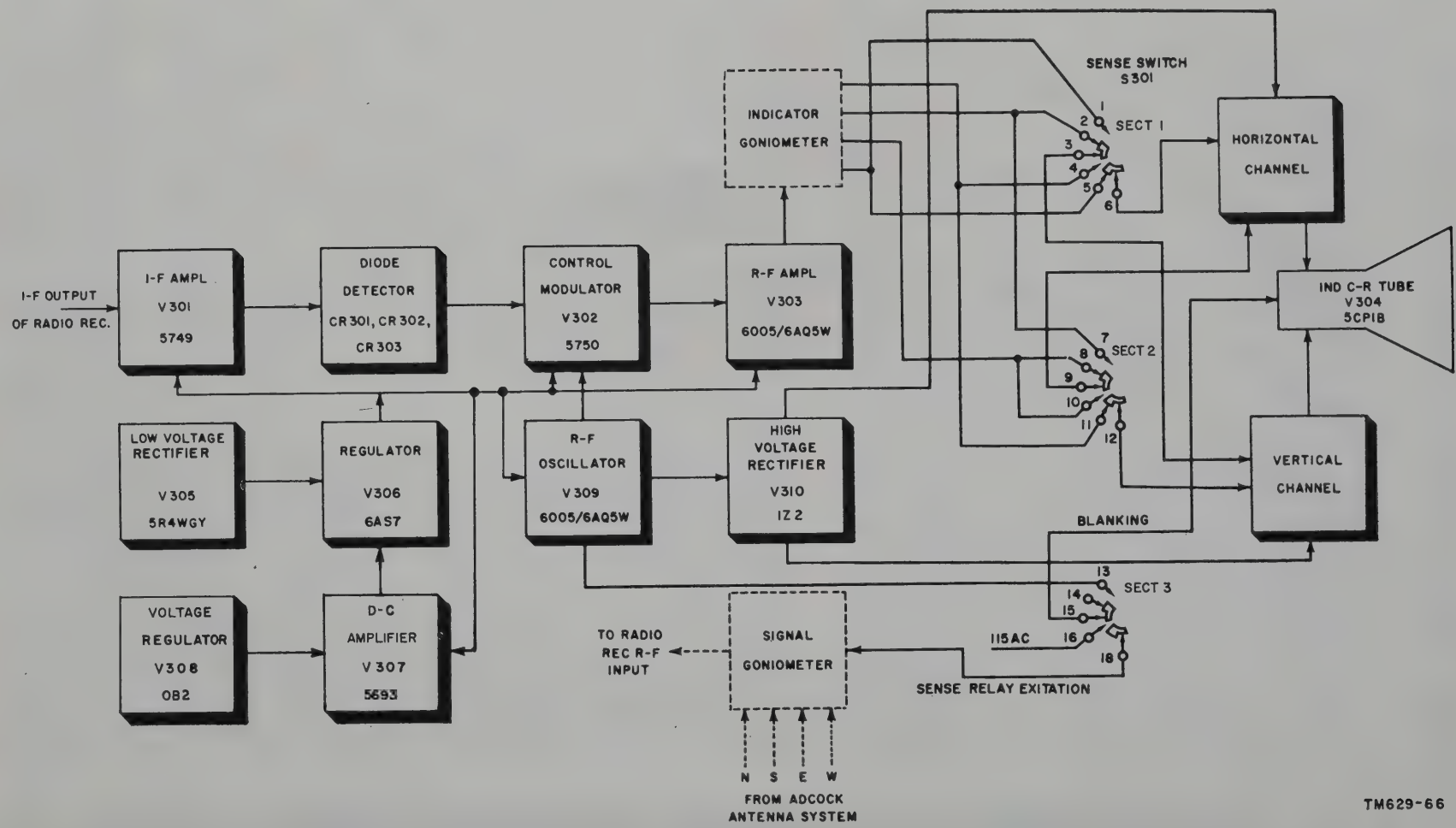


Figure 51. Azimuth indicator, block diagram.

applied is adjusted by SIZE control R313. The control modulator acts as a low gain RF amplifier in the absence of an input signal from the receiver. The primary of transformer T302 is tuned to insure adequate stage gain and 72-kc harmonic rejection. The secondary is connected to the input of RF amplifier V303. This class A RF amplifier stage (fig. 60) raises the power level enough to feed the low-impedance input of the indicator goniometer. The plate-tuned circuit provides the bulk of the harmonic rejection of the system, resulting in the desired wave form of deflection voltage.

b. As the indicator goniometer rotor changes position from the point of maximum to minimum induction into the stator coupled to the vertical deflection system, it produces a 54-cycle modulation envelope on the 72-kc signal. The stator windings of the horizontal deflection system are at right angles to the stator windings of the vertical deflection system, and produce a 54-cycle modulation envelope on the 72-kc signal at a 90° phase difference from the vertical system wave form.

c. The vertical and horizontal deflection plates are displaced 90° and therefore exert right angle forces on the cathode-ray tube beam. The resultant of the two deflection voltages applied to the deflection plates is a diametral line on the azimuth indicator screen. The position of the line is determined by the amplitude and polarity of the deflection voltages. Thus, as the indicator goniometer is rotated at 1,620 rpm, the deflection voltages change accordingly, and the line rotates (fig. 52).

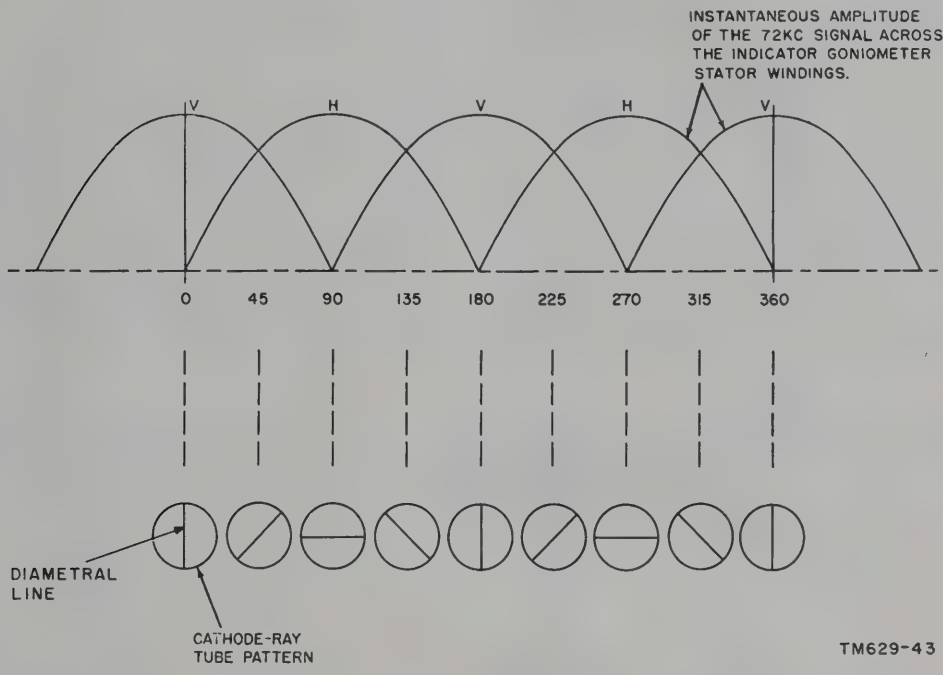


Figure 52. Development of indicator circular pattern by rotating line.

96. Development of Bearing Pattern

a. The spinning rotor of the signal goniometer modulates the received signal as it passes through the points of minimum and maximum induction from the stators connected to the antennas. The phase of this modulation depends on the direction of arrival of the signal (fig. 56). The signal goniometer modulated signal is fed to the receiver and converted to a 455-kc IF. The receiver output is then fed to the azimuth indicator where it is amplified and demodulated (fig. 42). The modulation envelope is now injected into the control modulator to impress the direction information on the circular pattern. The modulation voltage amplitude varies from 0 to —3 volts (fig. 59) and is capable of producing control modulator cutoff at its negative peak. As the voltage varies from 0 to —3 volts, the amplitude of the control modulator output varies from maximum to cutoff. Therefore, the rotating line varies from a 4-inch length down to a dot size in accordance with the rate of negative voltage increase. Since the null of the wave form results in

maximum line length, the bearing assumes the shape of a sharp-tipped propeller. The null of the wave form is 90° removed in phase from the maximum signal position and, therefore, a 90° bearing displacement exists.

b. The 90° displacement in bearing is compensated for by the connections between the indicator goniometer and the deflection circuits of the indicator (fig. 54). The east-west stator of the indicator goniometer is connected to vertical deflection transformer T304; the north-south stator of the indicator goniometer is connected to horizontal deflection transformer T305. If these connections were not made, each bearing would be in error by 90°.

97. Development of Sense Pattern

The propeller pattern displayed on the cathode-ray tube indicates a direct and reciprocal bearing which can be marked accurately by setting the alidade hairline to bisect the pattern. The indication at the hairline is a bidirectional bearing; that is, the signal can be arriving from either of two directions separated by 180°. One additional step is necessary to eliminate the reciprocal bearing and to determine the bearing which will indicate the exact direction of the signal. This display is called the sense pattern which shows up in various shapes unsuitable for obtaining a setting of the alidade, but always occurs in that half of the circle *opposite* the direct bearing. The sense pattern is accomplished by two separate simultaneous operations; one is a signal goniometer output wave form change produced by operation of the signal goniometer sense relay, and the other is a cathode-ray tube pattern shift of 90° in conjunction with half-cycle blanking of the cathode-ray tube by the 72-kc voltage in the indicator (F1 and G3, fig. 54).

a. Goniometer Sensing Function. The sensing arrangement does not require the use of a separate sense antenna. The sampling of the voltages from each antenna by operation of the sense relay creates a pattern which would be produced by a vertical antenna positioned at the center of the spaced antenna system. Assuming a signal from the south, an antenna pattern (A, fig. 55) is obtained in the north-south antenna system and the signals induced in the east-west antenna system cancel. The voltage induced in the phantom sense antenna is 90° removed in phase from each lobe (B, fig. 55). The sense voltage is shifted another 90° by capacitor C543 and the inductance of rotary transformer T541, thus making it in phase with the south antenna lobe and out of phase with the north antenna lobe. The addition of the lobes and the sense voltage would result in the cardioid pattern shown in C, figure 55. Reducing the sense voltage to one-

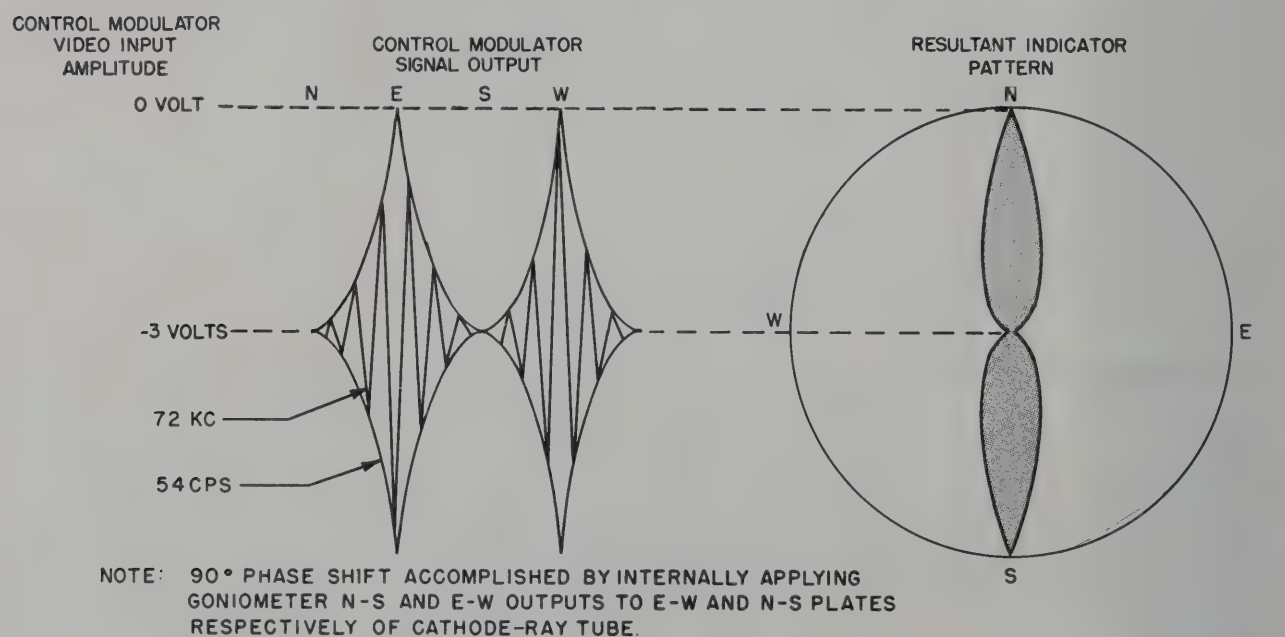
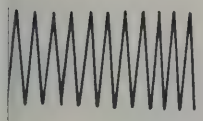


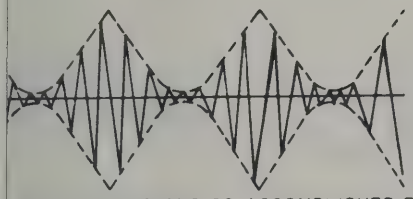
Figure 53. Relationship between control modulator wave form and resultant propeller-shaped pattern.

DULATOR OUTPUT



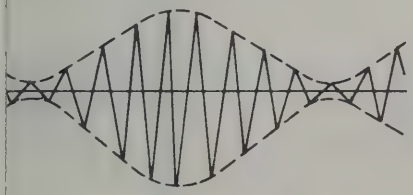
E1

S W N E S



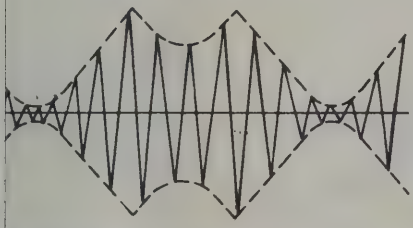
E2

T BETWEEN E2 AND G2 ACCOMPLISHED BY
PLYING GONIOMETER N-S AND E-W OUTPUTS
S PLATES RESPECTIVELY OF CATHODE-



E3

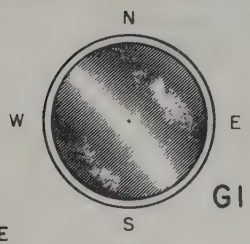
ED DURING NEGATIVE HALF OF CYCLE



E4

D DURING NEGATIVE HALF OF CYCLE

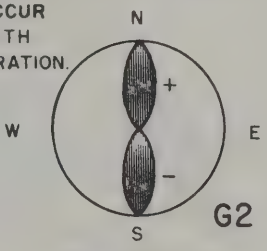
SCOPE PATTERNS



G1

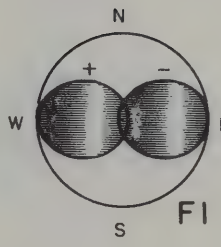
NO
SIGNAL CONDITION

PATTERNS NOT VISIBLE
TO OPERATOR SINCE
90° ROTATION AND 1/2
CYCLE BLANKING OCCUR
SIMULTANEOUSLY WITH
SENSE SWITCH OPERATION.

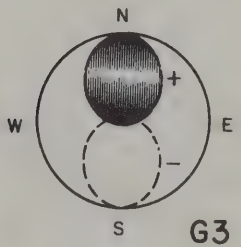


G2

SIGNAL BEARING

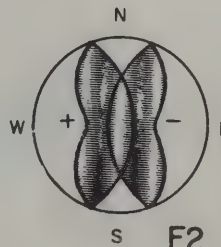


F1

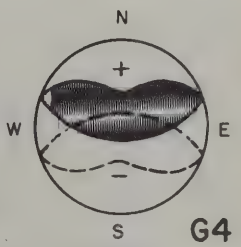


G3

SENSE



F2



G4

SENSE

TM688-68

maximum line length, the bearing assumes the shape of a sharp-tipped propeller. The null of the wave form is 90° removed in phase from the maximum signal position and, therefore, a 90° bearing displacement exists.

b. The 90° displacement in bearing is compensated for by the connections between the indicator goniometer and the deflection circuits of the indicator (fig. 54). The east-west stator of the indicator goniometer is connected to vertical deflection transformer T304; the north-south stator of the indicator goniometer is connected to horizontal deflection transformer T305. If these connections were not made, each bearing would be in error by 90°.

97. Development of Sense Pattern

The propeller pattern displayed on the cathode-ray tube indicates a direct and reciprocal bearing which can be marked accurately by setting the alidade hairline to bisect the pattern. The indication at the hairline is a bidirectional bearing; that is, the signal can be arriving from either of two directions separated by 180°. One additional step is necessary to eliminate the reciprocal bearing and to determine the bearing which will indicate the exact direction of the signal. This display is called the sense pattern which shows up in various shapes unsuitable for obtaining a setting of the alidade, but always occurs in that half of the circle *opposite* the direct bearing. The sense pattern is accomplished by two separate simultaneous operations; one is a signal goniometer output wave form change produced by operation of the signal goniometer sense relay, and the other is a cathode-ray tube pattern shift of 90° in conjunction with half-cycle blanking of the cathode-ray tube by the 72-kc voltage in the indicator (F1 and G3, fig. 54).

a. Goniometer Sensing Function. The sensing arrangement does not require the use of a separate sense antenna. The sampling of the voltages from each antenna by operation of the sense relay creates a pattern which would be produced by a vertical antenna positioned at the center of the spaced antenna system. Assuming a signal from the south, an antenna pattern (A, fig. 55) is obtained in the north-south antenna system and the signals induced in the east-west antenna system cancel. The voltage induced in the phantom sense antenna is 90° removed in phase from each lobe (B, fig. 55). The sense voltage is shifted another 90° by capacitor C543 and the inductance of rotary transformer T541, thus making it in phase with the south antenna lobe and out of phase with the north antenna lobe. The addition of the lobes and the sense voltage would result in the cardioid pattern shown in C, figure 55. Reducing the sense voltage to one-

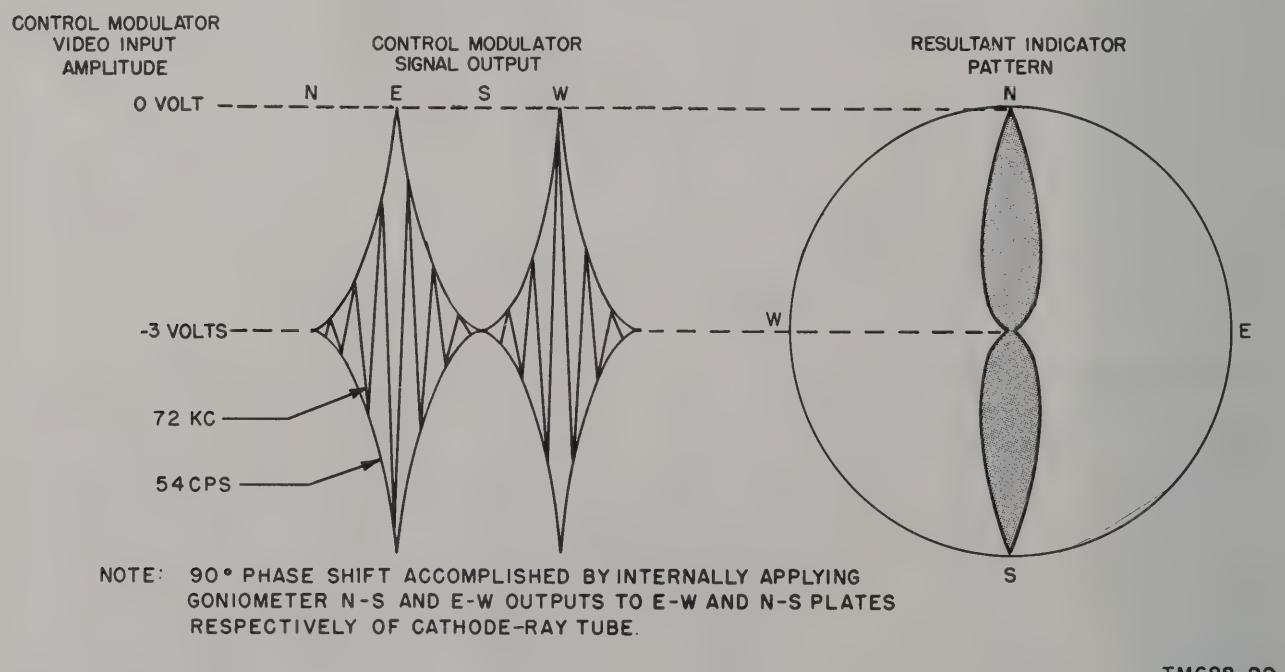


Figure 53. Relationship between control modulator wave form and resultant propeller-shaped pattern.

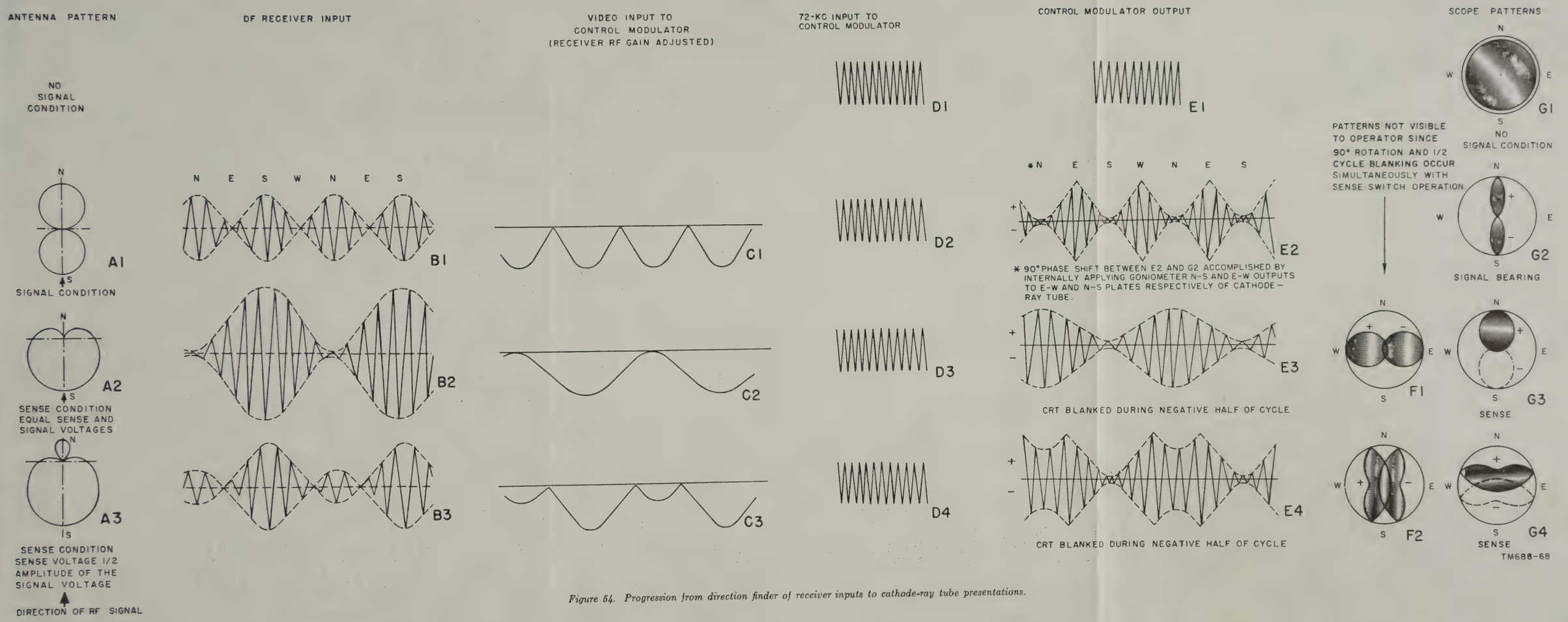
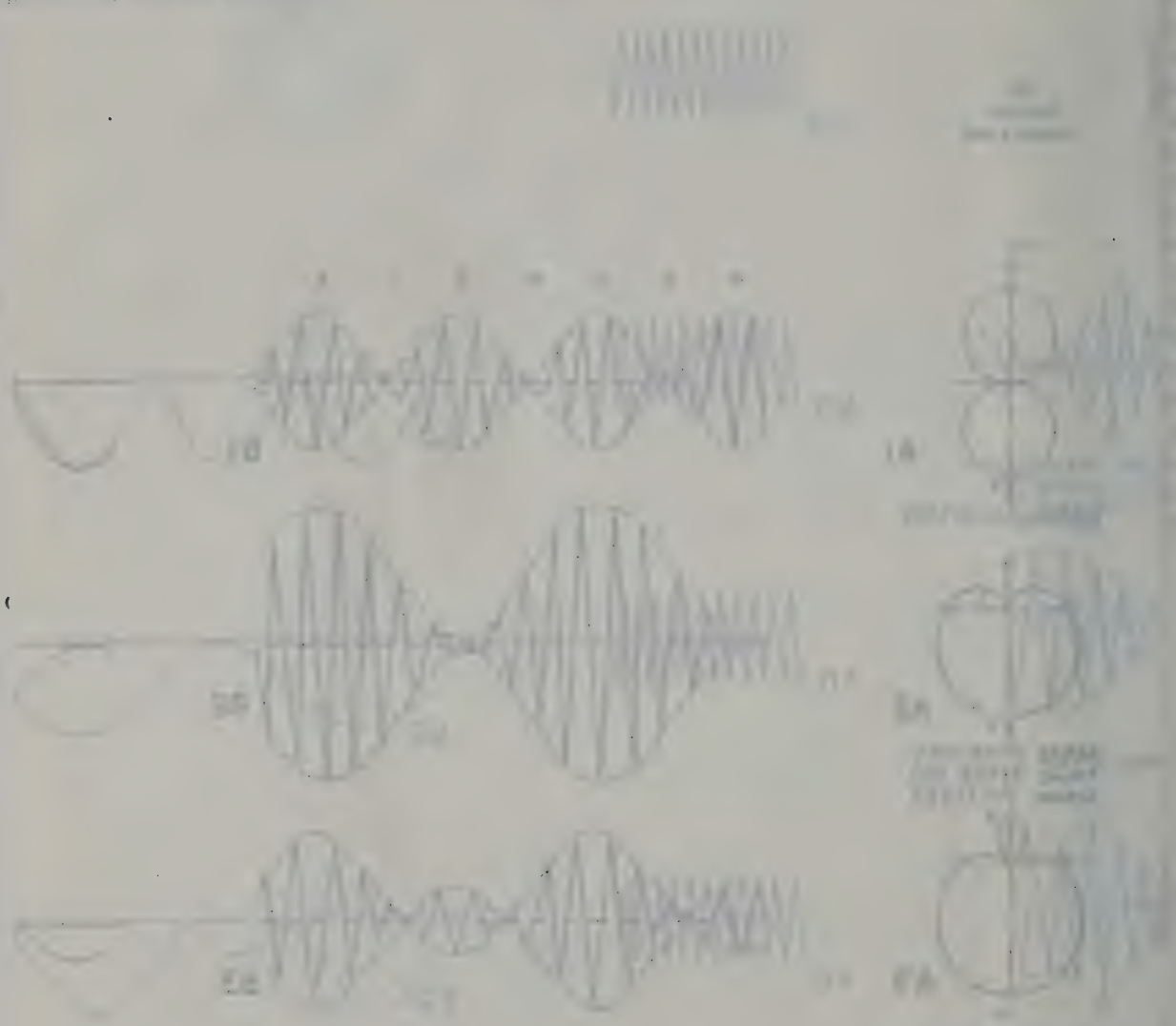
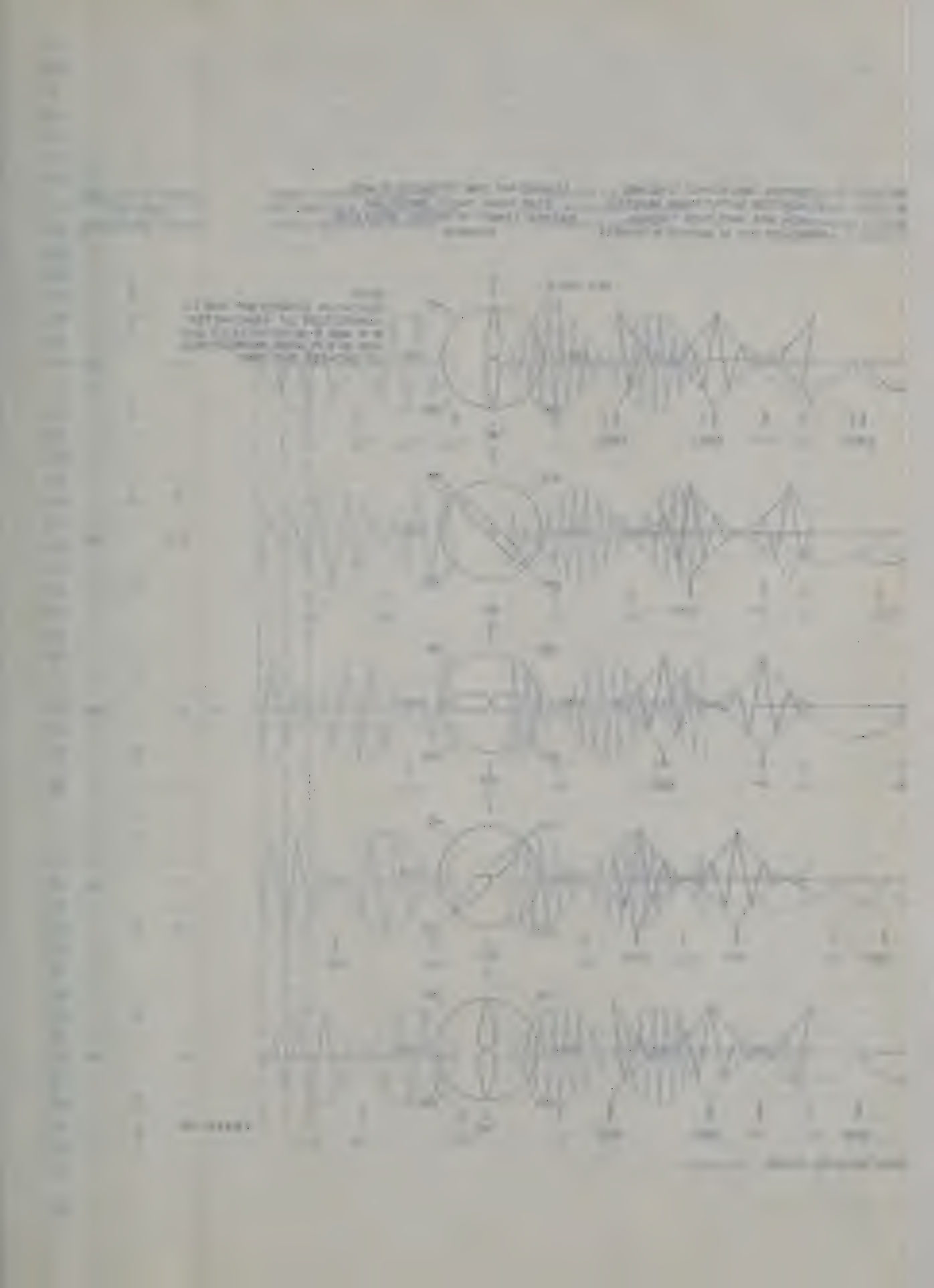
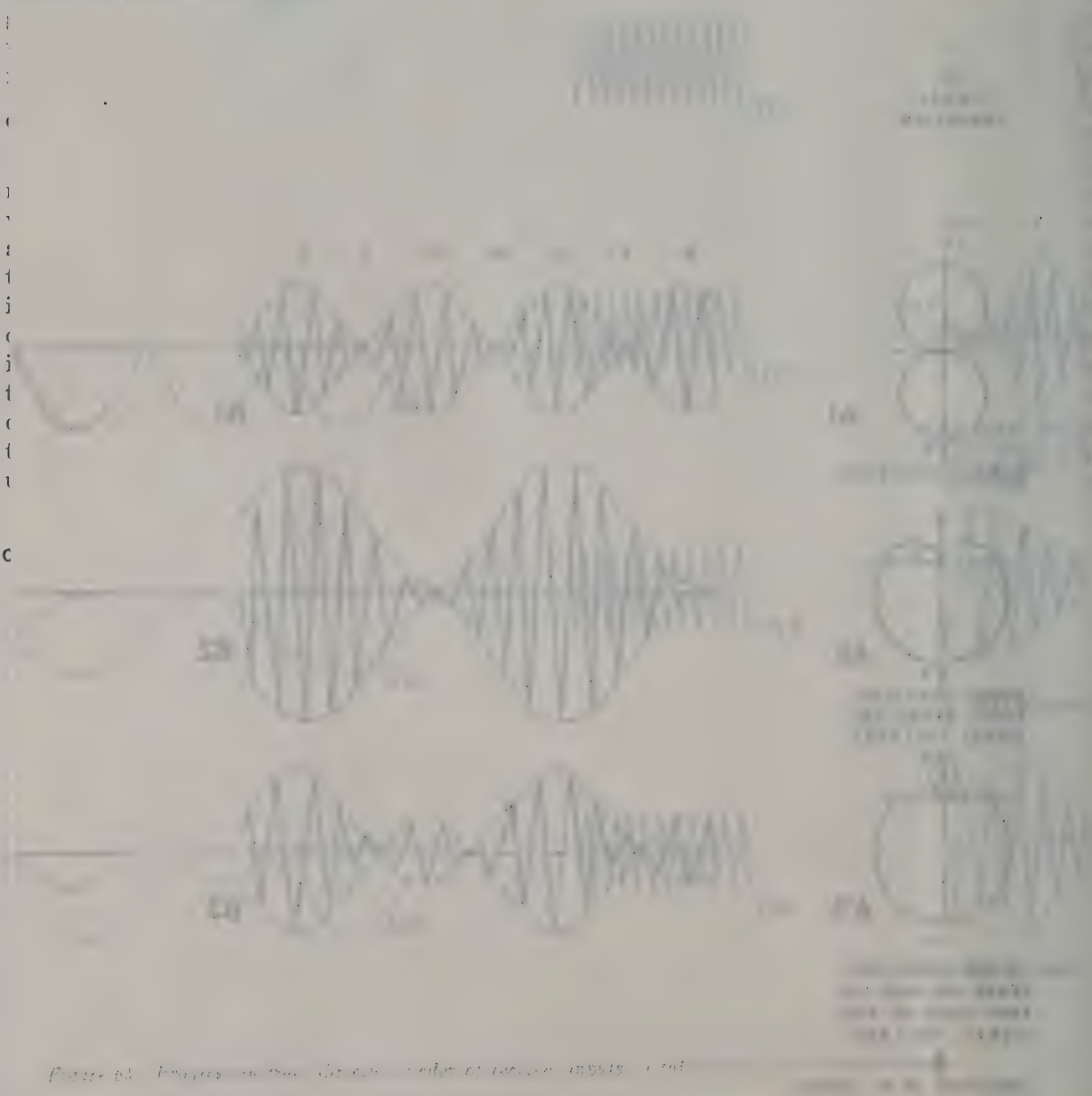


Figure 54. Progression from direction finder of receiver inputs to cathode-ray tube presentations.







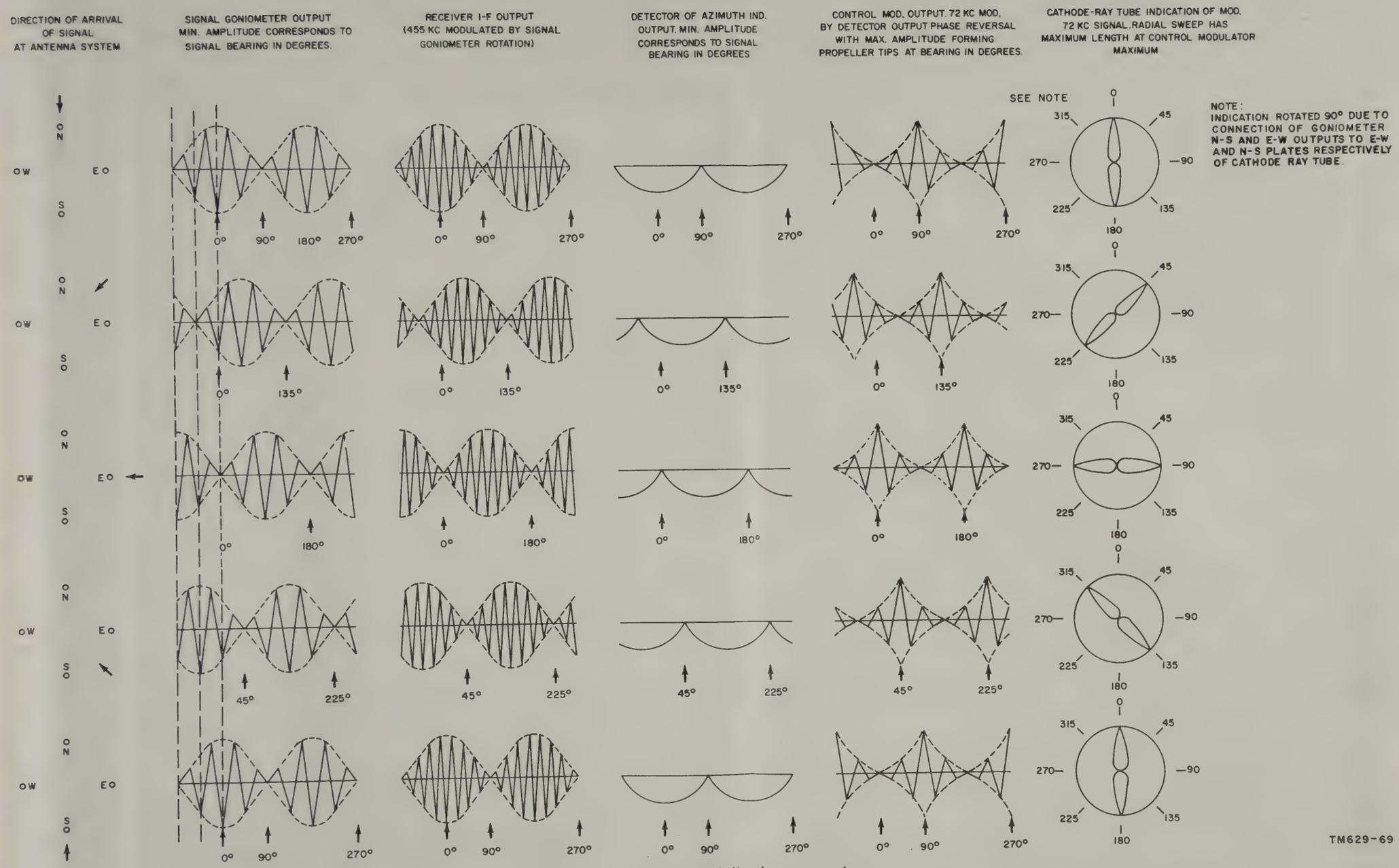
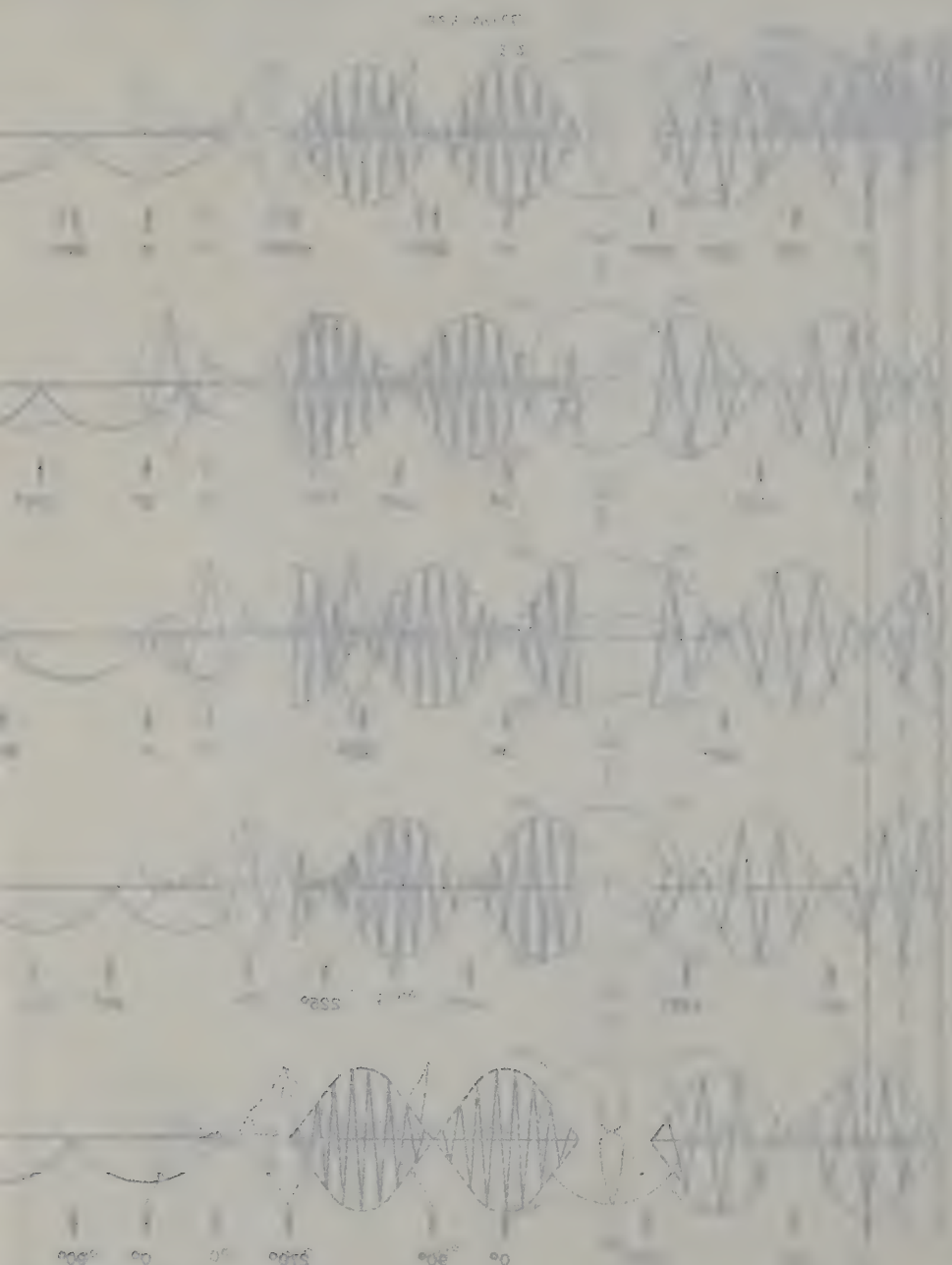


Figure 56. Effect of signal direction on wave forms.



half of the signal voltage with resistors R541, R542, R543, R544, and R547 (fig. 91) and the turns ratio of the rotary transformer results in the pattern shown in D, figure 55. This sense voltage is applied to the receiver and ultimately to the azimuth indicator and results in an arrowhead pattern on the indicator screen.

b. Indicator Sensing Function. The amplitude of the sense voltage (*a* above) is maximum in the direction of the arriving signal. However, the cathode-ray tube pattern was shifted 90° in the cable connection to the azimuth indicator. Depressing the SENSE switch reverses connections to the horizontal and vertical deflection circuits to cancel the 90° shift in cabling.

c. Radial Development. During presentation of the propeller pattern, the indicator pattern is formed by a diametral line across the indicator screen. During sense operation, one-half of the sweep is blanked, leaving a radial line. If this were not done, two arrowhead patterns would be formed: the proper pattern and a second pattern exactly opposite the first. Depressing the SENSE switch applies a portion of the 72-kc sweep voltage to the grid of the indicator cathode-ray tube. During the negative alternation of this voltage, the cathode-ray tube is cut off and only one-half of the trace appears on the screen.

d. Sense Pattern. The simultaneous 90° rotation and one-half trace blanking of the indicator presentation produces the arrowhead sensing pattern pointing to the bearing of the incoming signal.

98. IF Amplifier
(fig. 57)

The 455-kc goniometer-modulated signal from the receiver is amplified in the indicator by IF amplifier pentode V301. The signal is coupled from the receiver through coaxial connector J302 to the low-impedance primary winding of T301 in the azimuth indicator. The secondary grid-connected winding of T301 is tuned by fixed capacitor C301. The IF amplifier plate coil L301 is tuned to resonance by C303 and C304 which form a capacity voltage divider with the output taken from the junction of the capacitors. This divider helps maintain circuit Q by load decoupling, and also prevents diode overloading on excessive signals. Resistor R305 and capacitors C302A and C302C comprise a plate decoupling network. Resistor R302 is the fixed cathode resistor and is used to maintain a minimum bias condition. Potentiometer R301 is the IF gain control and accomplishes its purpose by variation of bias on the IF amplifier. Resistors R303 and R304 form a voltage divider network to provide the correct screen grid voltage. Capacitor C302B is the IF amplifier screen bypass capacitor. Negative feedback is introduced in the IF amplifier by omitting the bypass capacitor in the cathode circuit. This tends to hold the input capacity of the tube constant. If the cathode were bypassed, grid bias variations would cause changes in input capacity with resultant detuning of the grid tuned circuit.

99. Detector Circuit
(figs. 57 and 58)

a. The detector circuit consists of crystals CR302 and CR303 and resistors R306 and R307 (fig. 57). The detector circuit demodulates the amplitude-modulated 455-kc output from the IF amplifier and shapes the modulation envelope for application to the control grid of the control modulator. The straight line portion of the crystal symbols represents the plates. Electron current flow through the crystals is opposite to the direction of the arrowhead.

b. The amplitude-modulated 455-kc input to the detector circuit is shown in A, figure 58. The positive alternations of the 455-kc input are limited by crystal CR301 which conducts during the positive alternation. With only CR301 in the circuit, the detector output would be the amplitude-modulated negative alternations of the 455-kc signal. Crystals CR302 and CR303 and resistor R306 are added to the circuit to distort the modulation envelope to produce sharper propeller tips.

c. The voltage-resistance curve of the crystal diodes is shown in B, figure 58. The forward resistance (resistance to current flow from cathode to plate) is presented on the horizontal axis and the forward voltage (plate positive with respect to the cathode) is presented on the vertical axis. The forward resistance of the crystal is high for low forward voltages and low for high forward voltages. The resistance of the series circuit, consisting of crystals CR302 and CR303 and resistor R306, varies as the amplitude of the input voltage varies. When the modulation envelope is minimum, minimum forward voltage is applied to the crystals, and the forward resistance of the series circuit is maximum. When the modulation envelope is maximum, maximum forward voltage is applied to the crystals, and

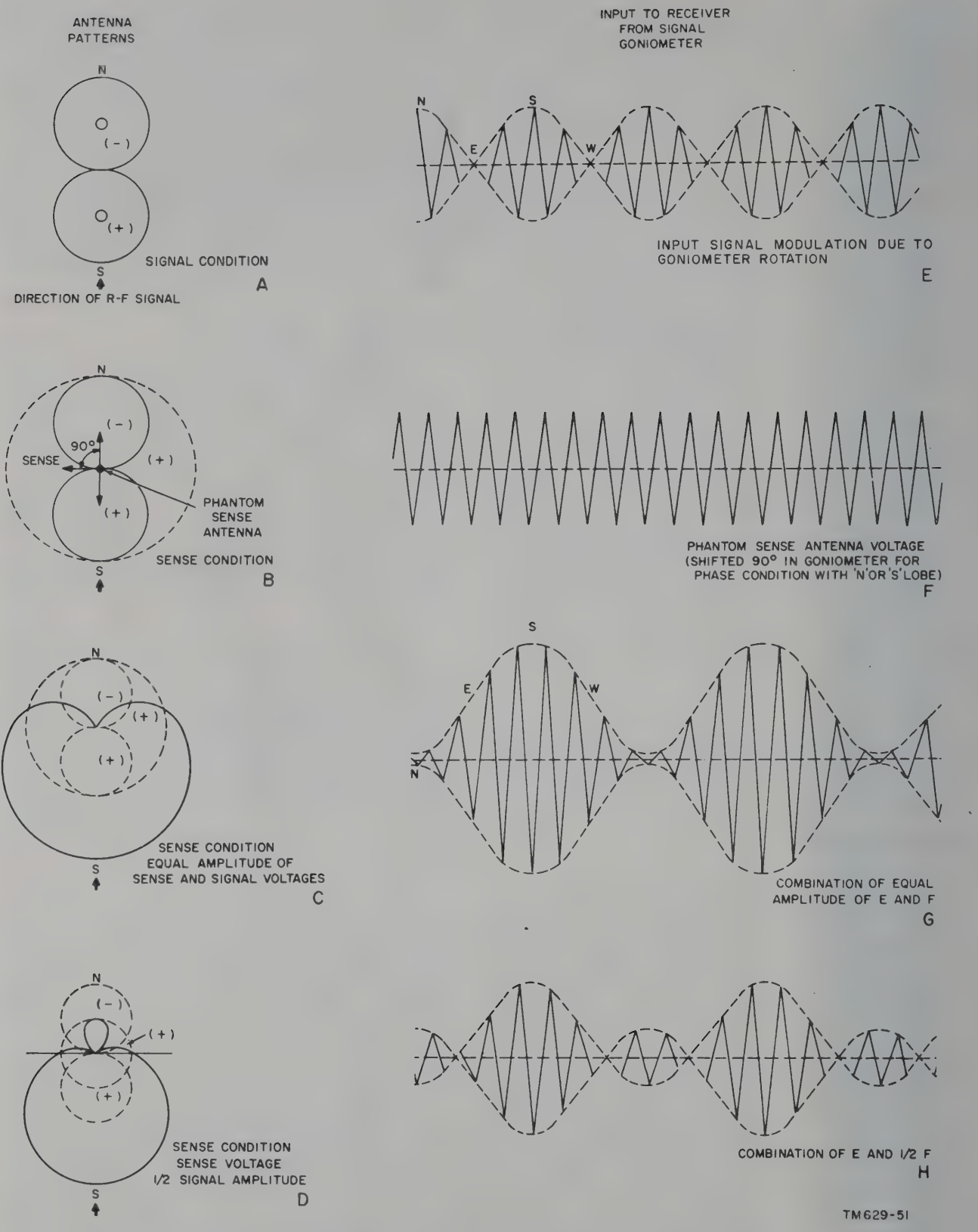


Figure 55. Relation of antenna sensing response to receiver input wave forms.

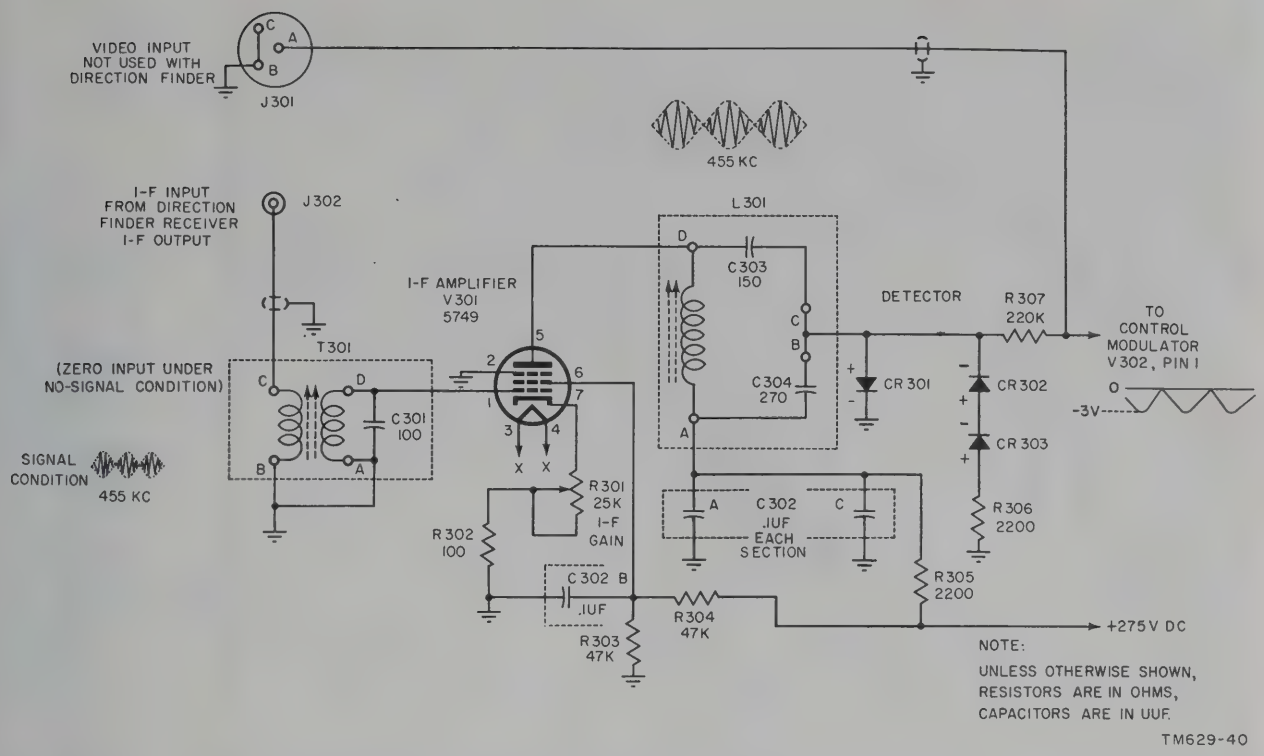


Figure 57. IF amplifier and detector, functional schematic diagram.

the forward resistance of the series circuit is minimum. During the minimums in the modulation envelope, the load on the signal source is minimum and the signal is not distorted. During the maximums in the modulation envelope, the load on the signal source is maximum and the signal is limited. Resistor R306 limits the value of the lowest resistance of the series circuit. Resistor R307 and the capacitance of the cable that connects the detector output to the control modulator filter the 455 kc. The filtered output from the detector is shown in C, figure 58. The steep sides of the detector output which are the result of the distortion introduced by CR302 and CR303 result in sharp propeller tips on the bearing presentation. The detector output is connected by coaxial cable to the grid (pin 1) of control modulator V302.

100. Control Modulator

(fig. 59)

The function of control modulator V302, type 5750, is to combine the directional information from the detector with the 72-kc sweep voltage. The output of the control modulator is a 72-kc RF voltage which is amplitude-modulated by the negative voltage variations from the detector. Under the condition of no received signal (zero bias on the control grid), tube V302 amplifies the 72-kc output of the oscillator which is applied to its injection grid. The output amplitude at the plate is varied by SIZE control potentiometer R313 which adjusts the 72-kc input level.

a. Under the condition of received signal, the modulation-envelope output of the detector varies the bias on the control grid from 0 to −3 volts. With zero control grid bias, full amplification of the 72-kc signal is obtained. As the bias increases, the amplitude at the plate of V302 decreases until at −3-volt bias, zero output results.

b. The primary of T302 is the plate load impedance of V302 and is tuned to resonance by capacitors C307, C308, and C336. Resistor R362 broadens the tuning response by lowering the Q of the circuit. Capacitor C309 is the plate supply bypass. Capacitor C306 is the screen RF bypass capacitor and C305 is the low-frequency bypass capacitor. Resistors R310, R311, R312, and R308, and potentiometer R309 comprise a voltage divider with the screen voltage taken from the arm of potentiometer R309. The fixed positive voltage for the cathode is obtained from the junction of R308 and R309. Resistor R314 attenuates the 72-kc signal

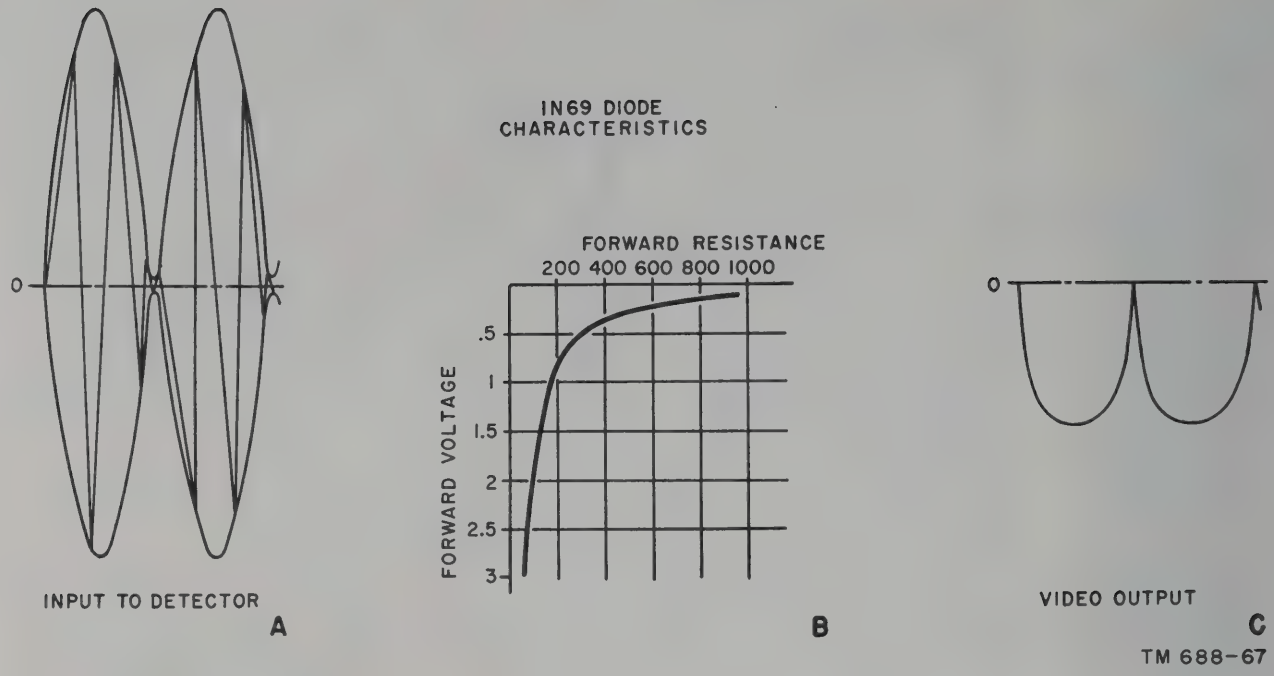


Figure 58. Detector analysis.

applied to the SIZE control to a convenient level for proper control.

c. Voltage gain in the control modulator is made almost independent of frequency, tube aging, and supply voltage change by employing negative feedback in the cathode circuit. This is accomplished by omitting the cathode bypass capacitor.

d. Because of phase shift in circuit components, the 72-kc blanking voltage is not in phase with the output of the control modulator. Capacitor C335 delays the phase of the 72-kc sweep to bring the two signals nearly in phase. This enables SENSE PHASING control R340 (fig. 61) to bring the two signals exactly in phase. Transformer T302 (fig. 59) couples the output of the control modulator to RF amplifier V303 (fig. 60).

101. RF Amplifier
(fig. 60)

RF amplifier pentode C303, a type 6005/6AQ5W, raises the modulated signal to the power level required at the input of the indicator goniometer. The grid signal from the control modulator is applied to the grid of V303. The primary of T303 is the plate load impedance of V303 and is resonated by capacitors C310 and C311. Plate tuning is accomplished by adjusting the slug of T303 which changes the inductance. Capacitors C313 and C314 bypass the plate supply. Resistor R315 is the cathode bias resistor, and C312 is the cathode bypass capacitor.

102. Deflection and Indication Circuits
(fig. 61)

During no-signal conditions, the indicator tube displays a filled-in circular pattern. When a signal is received, a propeller pattern is formed. A change in direction of arrival of a signal causes a change in the phase of the modulation imposed by the signal goniometer, with a resultant change in the position of the propeller. The indicator goniometer acts as a two-phase transformer since a single-phase voltage is impressed on its primary (rotor) and a two-phase output is developed across the north-south and east-west secondary (stator) windings. The west-east stator is coupled to the deflection transformers by connectors J307 and J308, and the north-south stator by connectors J309 and J310. The two-phase stator voltages are raised to a level sufficient for proper cathode-ray tube deflection by transformers T304 (vertical) and T305 (horizontal). Resistors R316 and R317 are terminating resistors for connections from the indicator goniometer to the primary of T304. Variable capacitor C315 and fixed capacitor C316 resonate T304 to 72-kc and damping resistor R321 broadens its tuning response. SHAPE control potentiometer R320 acts as a variable load resistor across the lower half of the secondary wind-

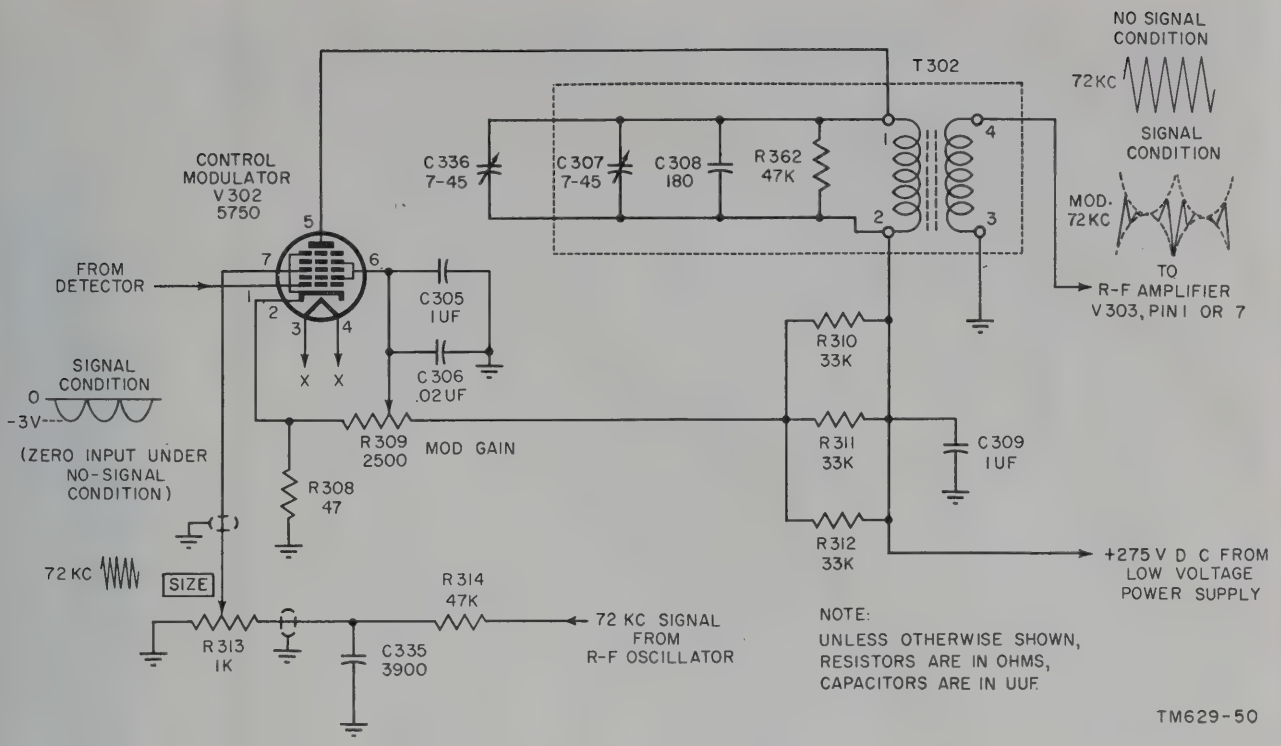


Figure 59. Control modulator, functional schematic diagram.

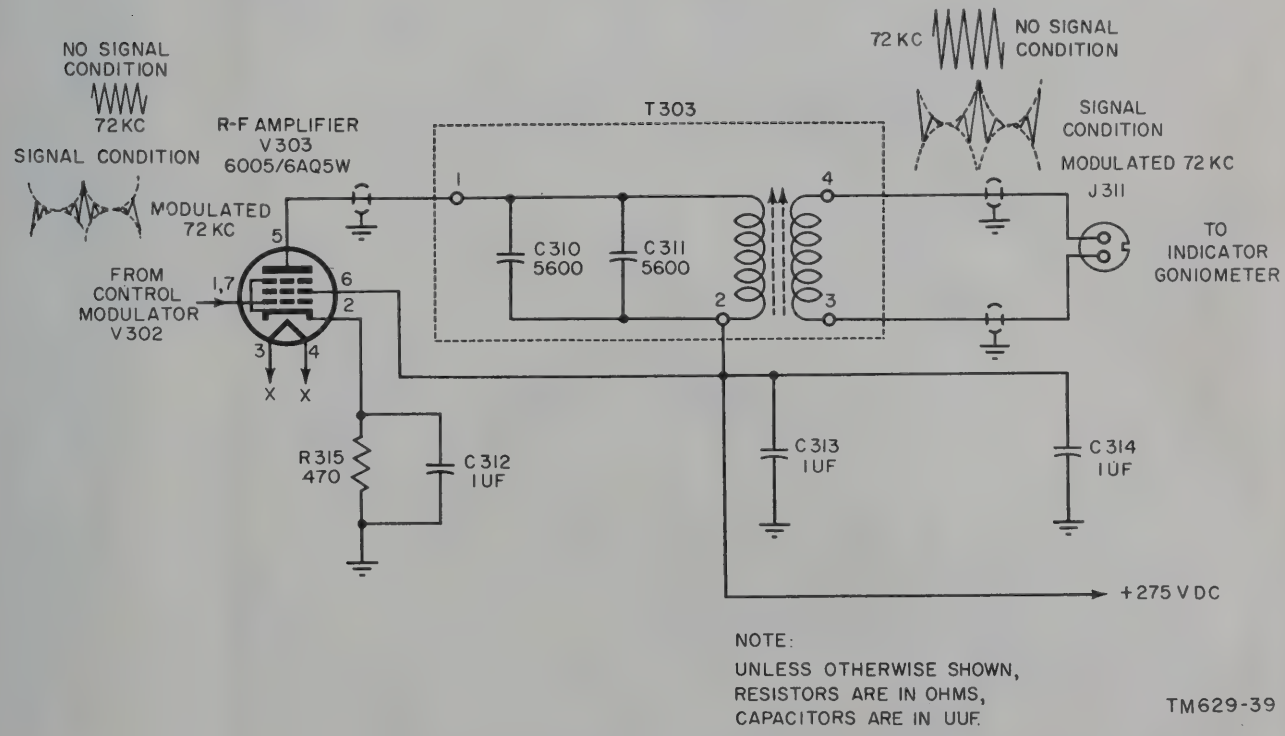


Figure 60. RF amplifier, functional schematic diagram.

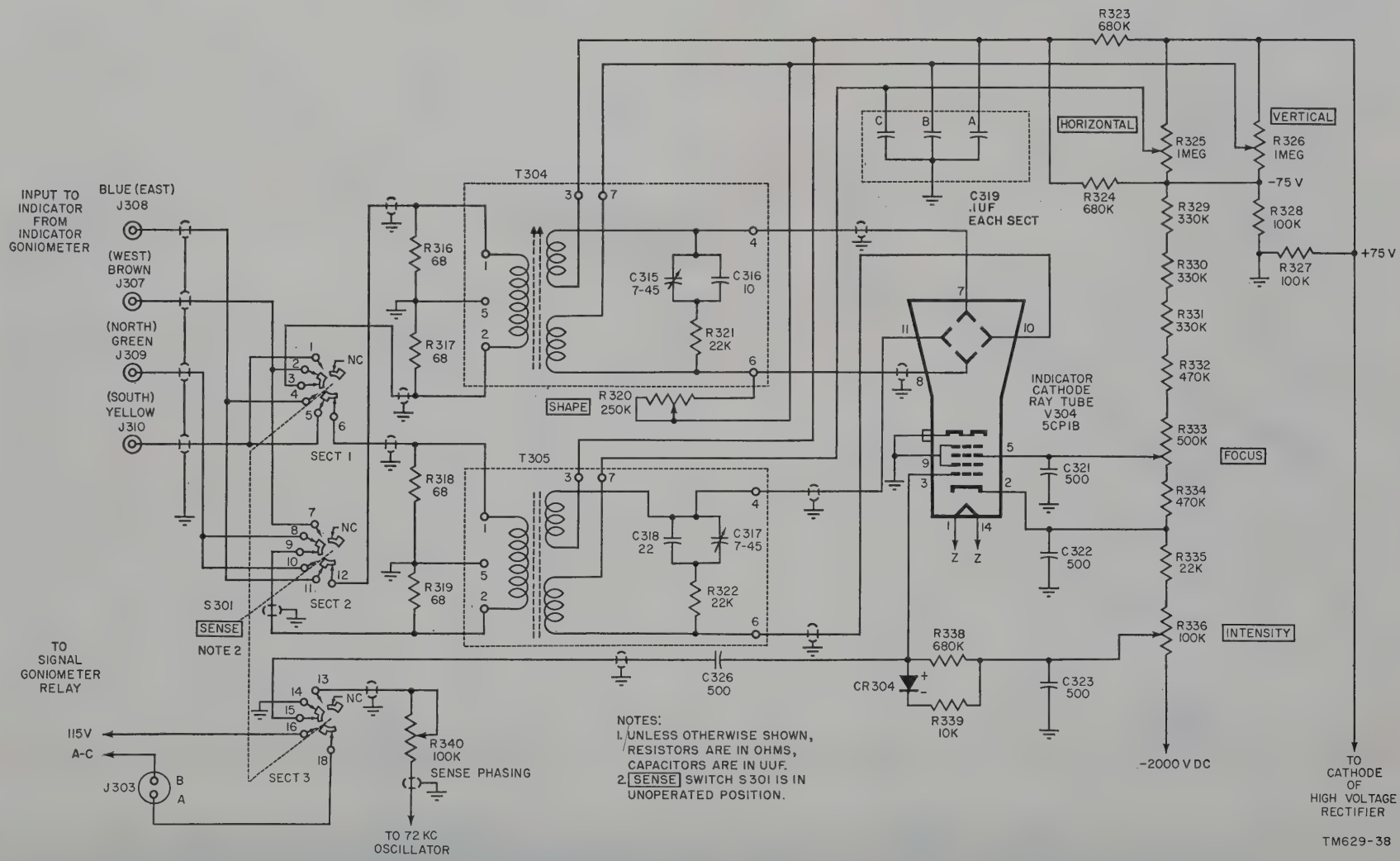


Figure 61. Deflection circuit, sense and high-voltage bleeder circuits, functional schematic diagram.

ing of T304 to reduce the amplitude of the voltage applied to the vertical deflection plates. This compensates for the greater deflection sensitivity in the vertical plane. Transformers T304 and T305 use two secondary windings each to enable application of separate dc centering voltages to the individual deflection plates. Capacitor C319 bypasses RF at the low sides of the secondary windings. Resistors R318 and R319 are terminating resistors for connections from the indicator goniometer to the primary of T305. Variable capacitor C317 and fixed capacitor C318 resonate T305 to 72 kc and damping resistor R322 broadens its tuning response.

103. High-Voltage Bleeder and Centering Circuit

(figs. 61 and 62)

a. The high-voltage bleeder is connected across the output of the high-voltage supply and provides the means of obtaining the voltages necessary for adjusting the beam intensity and focus in addition to voltage necessary for beam centering. The bleeder consists of R336 (INTENSITY control), R335, R334, R333 (FOCUS control), R332, R331, R330, R329, R325 (HORIZONTAL centering), R326 (VERTICAL centering), R328, and R327.

b. With the cathode of cathode-ray tube V304 at a fixed potential, the grid voltage (negative with respect to cathode) is varied by potentiometer R336 to produce changes in beam intensity. Resistor R335 limits the beam intensity to the proper operating level. The arm of FOCUS control R333 connects to the focusing anode of V304 and provides an adjustable voltage (positive with respect to cathode) necessary for focusing. Capacitors C323, C322, and C321 bypass any 72-kc voltage present at the INTENSITY control, the cathode of V304, and the focusing anode of V304 respectively.

c. Resistor R327 is the only resistor in the voltage divider across which a positive voltage (with respect to ground) appears. This resistor is connected between the cathode of high-voltage rectifier V310 and ground and is the same value as R328. The common current flowing through the voltage divider produces the same drop across resistors R327 and R328. The voltage across resistor R328, however, is

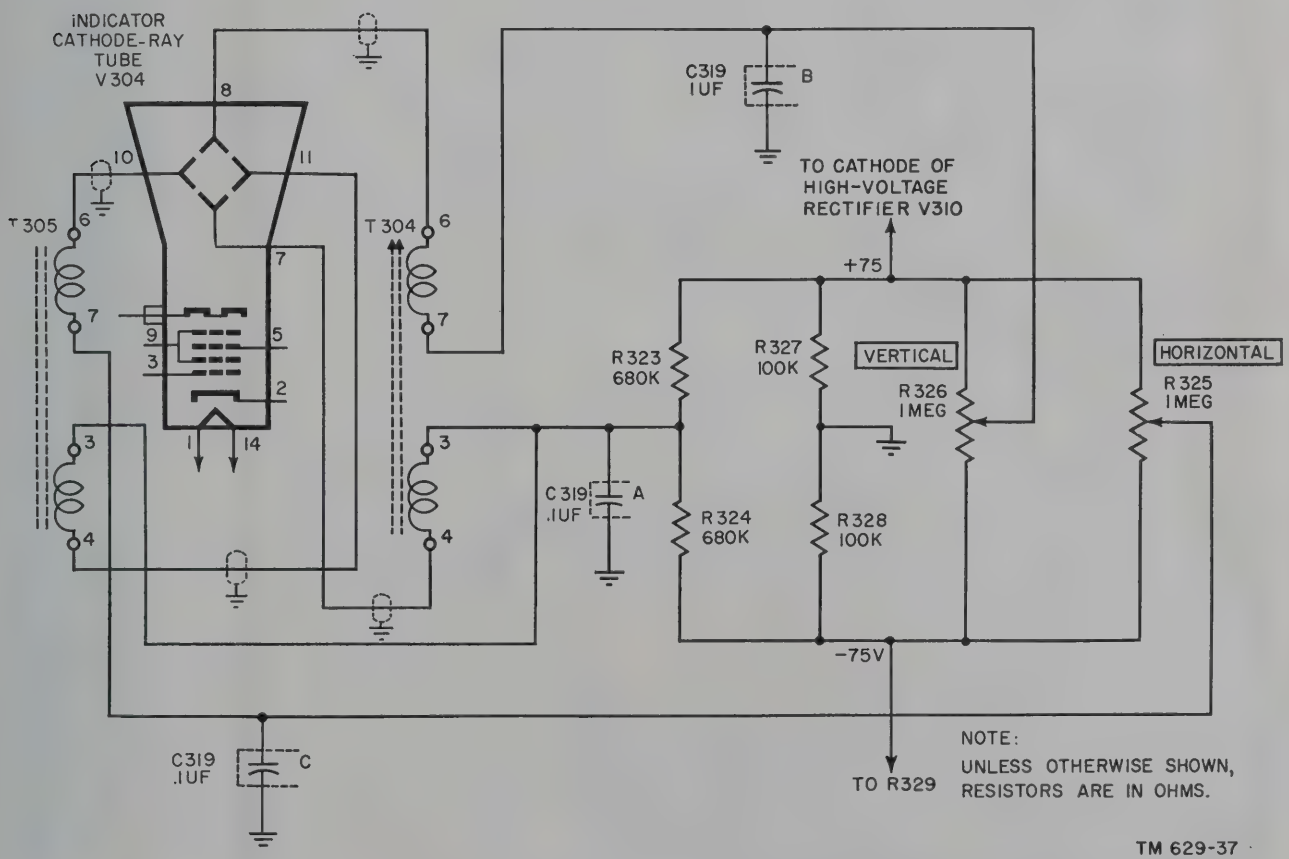


Figure 62. Indicator centering circuit, functional schematic diagram.

negative with respect to ground. Therefore, the voltage applied to one side of centering controls R325 and R326 is equal to, but of opposite polarity with, the voltage applied to the other side of these potentiometers. When the variable arms are set at midpoint, the voltage present between the arms and ground is zero. As the controls are rotated from one side of their midpoint position to the other, the voltage at the arms will vary in level and polarity. The arm of the VERTICAL centering control is connected to one of the vertical deflection plates of tube V304 through one-half of the secondary winding of T304. Likewise, the arm of the HORIZONTAL centering control is connected to one of the horizontal deflection plates of tube V304 through one-half of the secondary winding of T305. As the dc output voltages at the arms of these controls are varied by rotation of the controls, the vertical and horizontal positions of the pattern on the cathode-ray tube screen will vary also, thus permitting the display to be centered on the screen prior to operation.

d. Resistors R323 and R324 (fig. 62) maintain beam centering with changes in intensity. With low intensity, the voltages across R327 and R328 are equal in value but of opposite polarity. Since R323 and R324 are equal in value and are connected in series across R327 and R328, the voltage at the junction of these resistors is zero with respect to ground. These four resistors form a balanced bridge circuit. One horizontal and one vertical plate are connected at this junction point. With an increase in intensity, the voltage across R327 increases because of increased tube current (V304), and the voltage across R328 decreases because of a decrease in the high voltage. The decrease in high voltage is caused by the inherently poor regulation of an RF power supply. This change in voltage applied to the plates would cause the beam to change position. However, the junction point of R323 and R324, which was at zero potential, now assumes a positive potential (bridge circuit is now unbalanced). Thus it opposes the increasing voltage across R323 and effectively increases the voltage across R324. The net result is a floating ground on one of the vertical and one of the horizontal plates. This produces a dc voltage which opposes the dc voltage change on the other associated plates, thereby maintaining the beam at its original position.

104. Sense Circuit
(fig. 63)

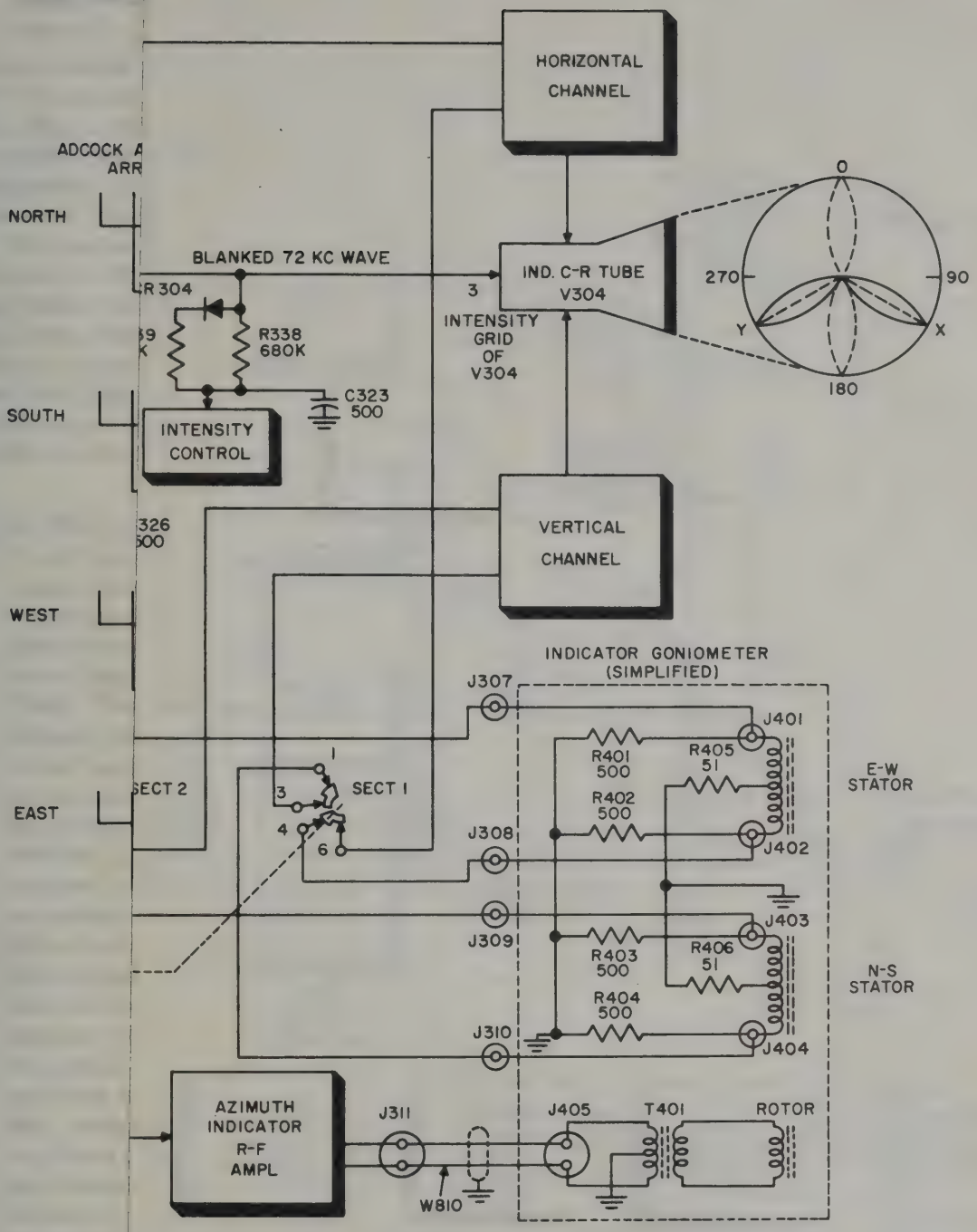
a. Development of the sense voltage is discussed in detail in paragraph 97. Operation of SENSE switch S301 performs three simultaneous functions.

(1) The sense relay in the signal goniometer is operated when 115-volt ac power is applied through contacts 16 and 18 of section 3 of SENSE switch S301 and connector J303. This results in changing the input to the receiver from a bearing wave form to a sense wave form.

(2) The indicator goniometer stator connections to the horizontal and vertical deflection systems are interchanged by the action of sections 1 and 2 of SENSE switch S301, producing a 90° pattern rotation.

(3) Section 3 of the SENSE switch connects blanking voltage to the indicator cathode-ray tube. One-half of the indicator sweep is blanked, producing a radial sweep instead of the normal diametral sweep.

b. The 72-kc output of the oscillator is altered in wave form and adjusted in phase to produce half-cycle blanking. The sine wave output of the oscillator is coupled to the grid of the cathode-ray tube through the sense-phasing control, section 3 of the sense switch, and capacitor C326, a high-voltage blocking capacitor. The network, consisting of R338, CR304, and R339, shapes the wave form to enable one-half cycle blanking and retention of overall pattern intensity with SENSE switch operation. On the positive half-cycle, the germanium diode forward resistance in series with R339 presents a low overall circuit impedance (shunting R338), permitting a small amount of voltage to be impressed on the cathode-ray tube grid during the positive half-cycle. This small positive voltage compensates for the decrease in intensity with a change from a diametrical to a radial line. On the negative half-cycle, the back resistance of the diode permits a high overall circuit impedance, permitting the larger amplitude negative half-cycle to be applied to the cathode-ray tube grid, and thereby producing beam cutoff. Potentiometer R340 (SENSE PHASING) and capacitor C326 act as a phase shift circuit which adjusts the phase of the 72-kc blanking voltage to coincide with the 72-kc sweep. Capacitor C323 is the low-impedance return path for the 72-kc sense voltage from the RF oscillator.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. SENSE RELAY K541 SHOWN IN SENSE-OPERATED POSITION.
3. SENSE SWITCH S301 SHOWN IN SENSE-OPERATED POSITION.

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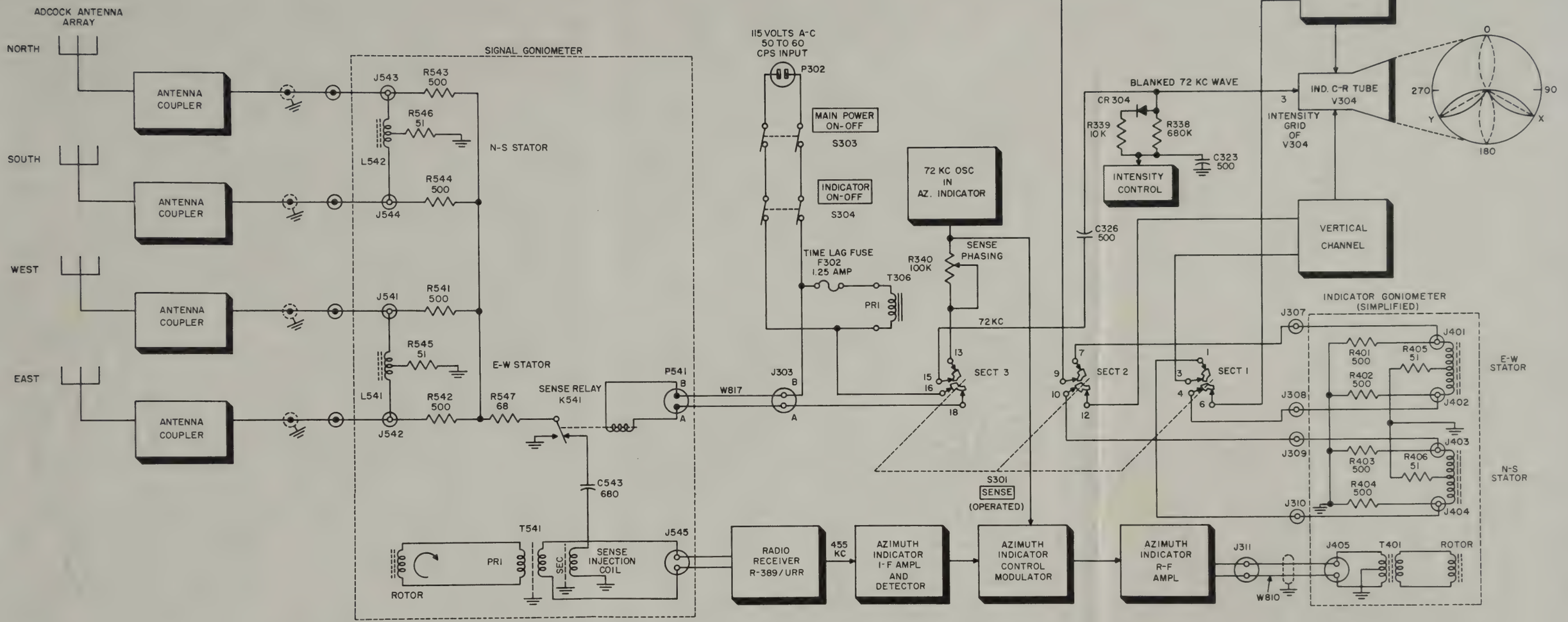

Figure 63. Sense circuit, functional schematic diagram.

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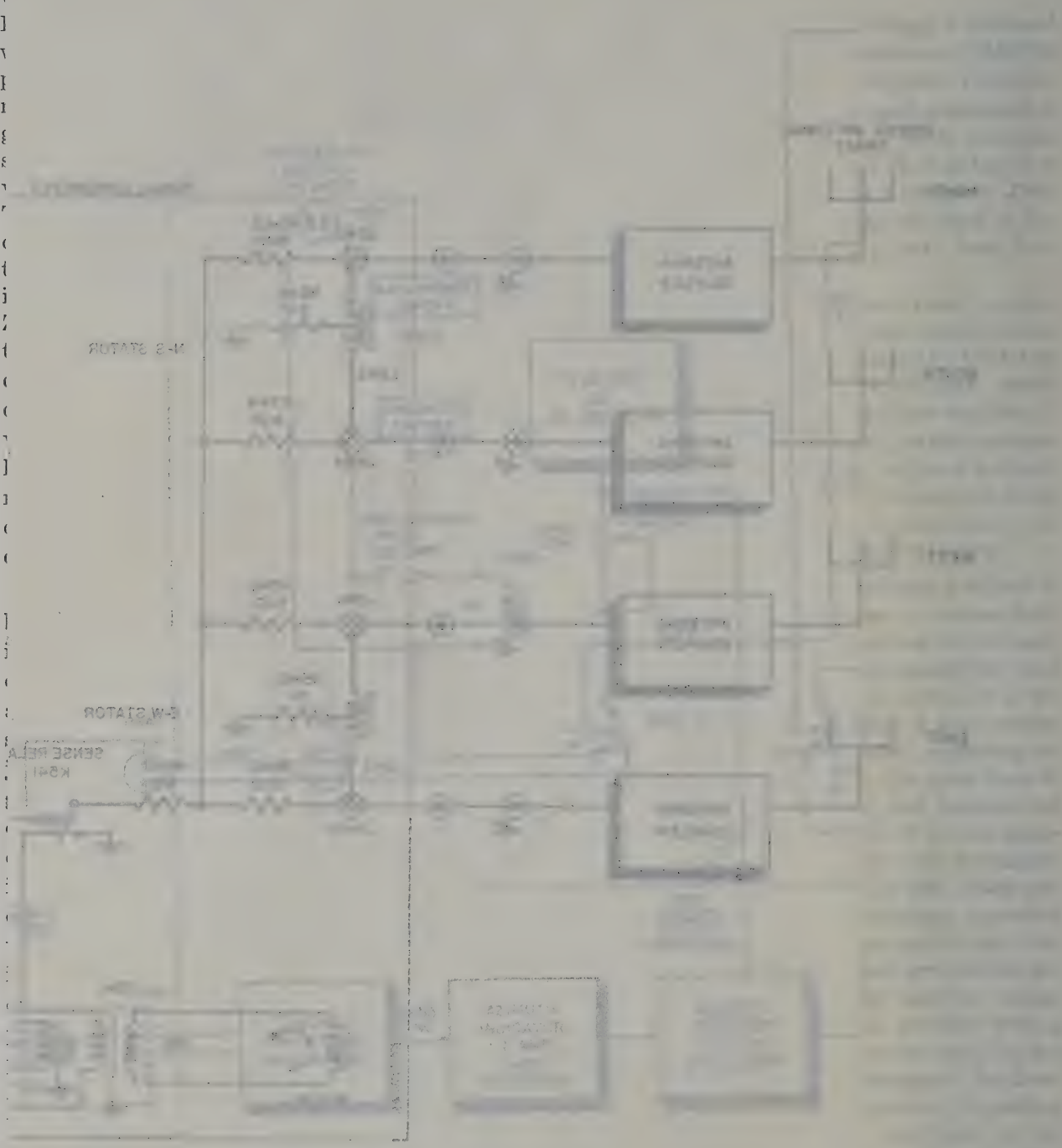


105. Power Control and Low-Voltage Regulated Power Supply
(fig. 64)

a. Power Control. The azimuth indicator input voltage, 115 volts 50 to 60 cps ac, is obtained from Junction Box J–95B/CRD–2 through connector P302. MAIN POWER switch S303 controls the direct application of power to the receiver through connector J305. Placing INDICATOR switch S304 in the ON position illuminates the alidade and applies power to T306 through fuse F302. With S303 and S304 in the ON position, placing GONIO-DRIVE switch S302 in the ON position supplies power to the goniometer drive assembly through J304 and fuse F301. This affords overload protection to the motor. Power application to the goniometer drive is evidenced by rotation of its azimuth scale.

b. Low-Voltage Power Supply.

(1) *Power transformer.* One low-voltage secondary winding (terminals 6, 7, and 8) of T306 supplies 6.4 volts ac to dial lamps E301 through E306 and the heaters of tubes V301, V302, V303, V306, V307, and V309. This winding also supplies power through pins C and D of connector J304 to dial lamps E701 and E702 in the goniometer drive. A second low-voltage winding provides filament voltage for rectifier tube 305, a type 5R4WGY. A high-voltage insulated winding supplies filament voltage to cathode-ray tube V304. The high-voltage secondary winding of T306 provides high-voltage ac for application to the plates of rectifier V305.

(2) *Rectifier.* Tube V305 is a full-wave rectifier which converts high-voltage ac to pulsating dc for application to the filter and regulator. The B+ output of the rectifier is taken from one side of the rectifier filament and is passed through a resistance-capacitance (rc) filter consisting of resistor R341 and capacitor C327. This filter removes the 120-cycle ripple. The output of the rc filter is applied to the regulator and hum suppressor circuits.

(3) *Voltage regulator.* The voltage regulator circuit furnishes a stable +275-volt dc output voltage over a wide range of operating conditions despite changes in the output load or ac line voltage.

(*a*) The output of the filter is connected to the load through series regulator tube V306, type 6AS7G, acting as a variable resistance, the value of which is controlled by V307. Resistors R353, R354 (voltage adjustment), and R355 form a voltage divider across the output load. The control grid of V307 is connected to the arm of R354 to sample the output voltage for control purposes. The cathode of V307 is maintained at constant potential by V308 (gaseous regulator) which serves as a reference element. Resistors R349 and R350 are in series with V308 to maintain proper starting potential and current drain for the gaseous regulator. Proper screen voltage level for V307 is obtained from a tap on the voltage divider formed by R348, R351, and R352. Resistors R345 and R346 are current balancing resistors, and R343 and R344 are grid stabilizing resistors for dual-triode V306. Resistor R342 is the plate load resistor of V307 across which control voltage for V306 is developed. Resistor R347 (hum balance) controls the amplitude and phase of applied hum voltage to the screen of V307. Capacitor C328 serves as a dc blocking capacitor to prevent interaction of dc potentials.

(*b*) With an increase in the B+ output across the load, whether due to load or line voltage change, there is a proportionate change in the positive direction upon the grid of V307 because the grid is connected to the arm of R354 (a part of the bleeder across the load). Since the cathode of V307 is maintained at a constant voltage by V308, a positive change in the grid potential of V307 produces a corresponding change in plate current. The increased plate current of V307 flowing through R342 increases the voltage across that resistor. Since the grid of V306 is connected to R342, an increase in the bias of V306 results. This increased bias raises the plate resistance of V306. Since V306 is in series with the load, an increase in its resistance decreases the output voltage, thereby tending to balance out the original increase

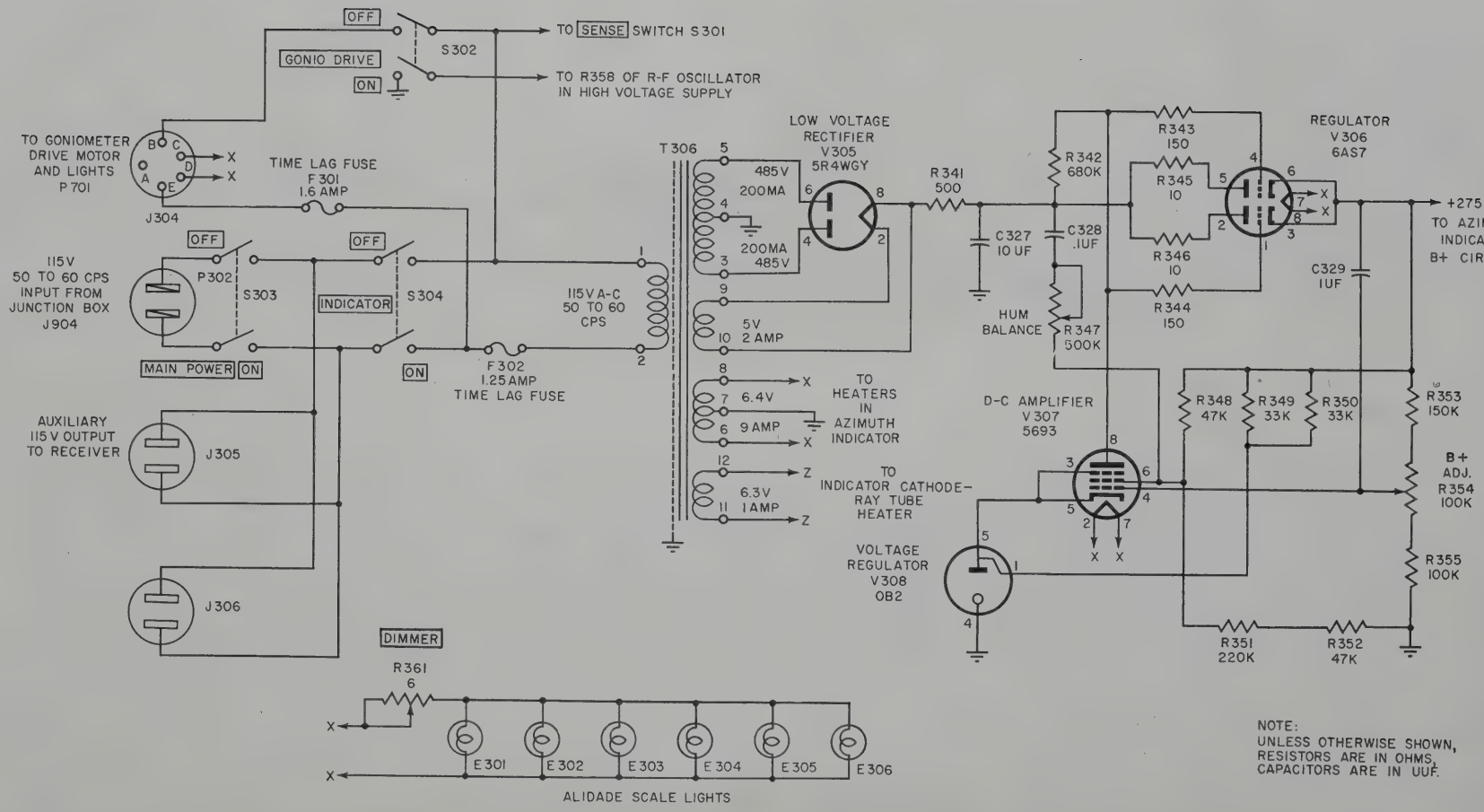


Figure 64. Low voltage power supply and voltage regulator, schematic diagram.

in load voltage. Coupling capacitor C329 enables the regulator to follow rapid changes in load voltage by feeding the change directly to the control grid of V307.

(*c*) A sample of the hum at the output of the filter is applied to the screen of V307, the amplitude and phase of which is controlled by R347. In an identical manner as described for load regulation, resistance of V306 is varied at a hum rate, opposing the alternate increase and decrease of output voltages and eliminating the hum.

106. High-Voltage Power Supply
(fig. 65)

This supply uses 72-kc oscillator V309 and a high-voltage rectifier to develop the 2,000-volt dc required for operation of cathode-ray tube V304, a type 5CP1B. In addition, the output of the oscillator provides the basic indicator sweep frequency.

a. Oscillator. A standard Colpitts oscillator is used with the primary of T307 (high-voltage transformer), serving as the inductive element of the tank. The tank capacity divider, which consists of capacitors C333 and C334, establishes the plate-to-grid feedback relationship. Capacitor C332 couples the grid of the oscillator to the tank circuit and also serves to block B+ from the grid. Coil L302 provides a vernier frequency adjustment through variation of circuit inductance. The flow of grid current through R359 provides the oscillator bias. Cathode bias developed by R358 provides protection for the oscillator tube in the event oscillation ceases. Coil L303, in conjunction with the screen bypass capacitor (one section of C331), serves to prevent RF leakage into B+ circuits. The other section of C331 bypasses cathode resistor R358. Resistor R357 is a parasitic suppressor.

b. High-Voltage Rectifier. The filament of high-voltage rectifier V310, a type 1Z2, is energized from a special secondary winding of T307. Resistor R360 is the filament voltage dropping resistor. The high-voltage secondary of T307 drives the plate of the half-wave rectifier. The half-wave rectifier output is then applied to the rc filter consisting of resistor R337 and capacitors C324 and C325. With the external high-voltage bleeder connected, a voltage of −2,000 volts with respect to ground is available at terminal 1 on terminal board E320. The filament of the rectifier is approximately +75 volts (terminal 2) to supply the necessary positive potentials for the beam-centering circuits. Capacitor C320 bypasses the filament of rectifier V310 to ground.

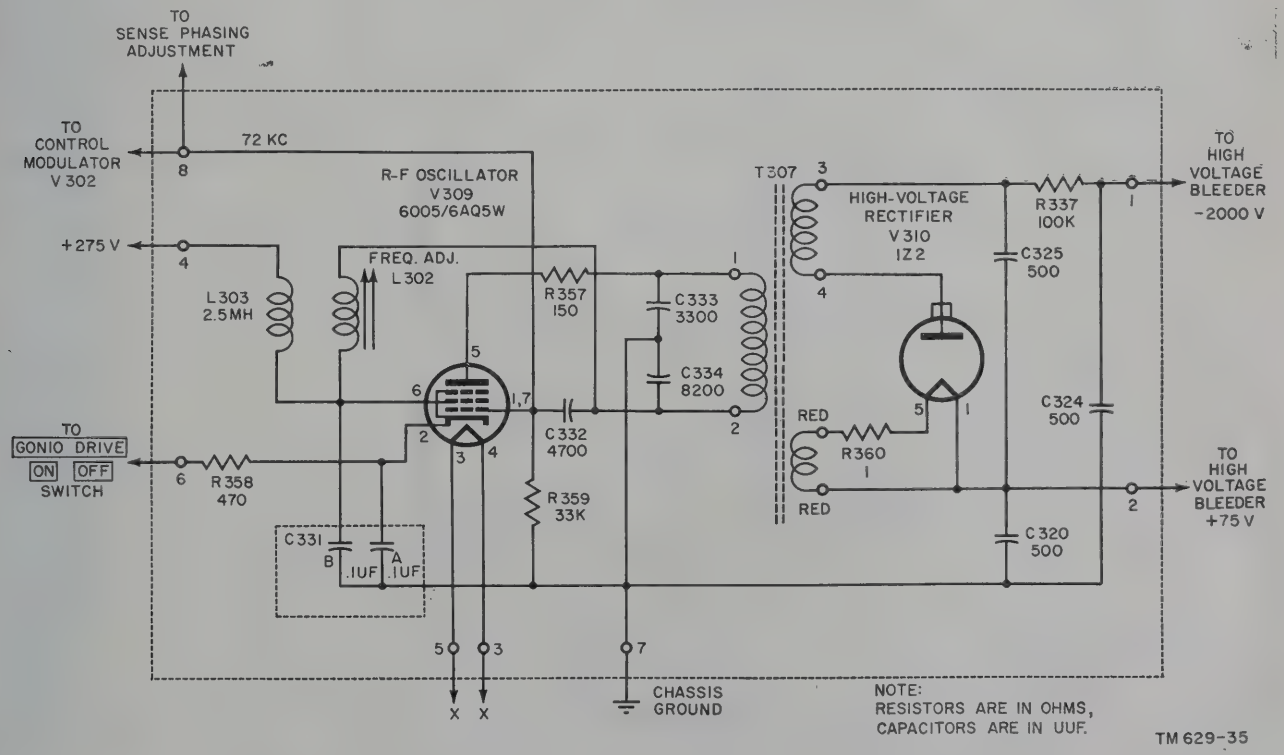


Figure 65. High-voltage power supply, schematic diagram.

107. General

Radio Transmitter T–339/UR (target transmitter) is a low-power, portable radio transmitter used as a test oscillator for the direction finder set. The target transmitter sends cw or am signals, selected by front panel controls, over a frequency range of 100 to 2,000 kc in three bands. The block diagram is shown in figure 66 and the complete schematic diagram is shown in figure 94. The B+ distribution diagram of the target transmitter is shown in figure 83. These diagrams may be used as a trouble-shooting aid.

108. Block Diagram

(fig. 66)

a. RF Oscillator. The RF oscillator consists of tube V601, a type 6AK6, in a tuned plate circuit. Slug-tuned transformers provide the resonant and feedback circuits for the frequency bands covered.

b. Power Amplifier. Power amplifier V602, a type 6AK6, amplifies the RF signal developed by the RF oscillator and acts as an isolation circuit between the oscillator and antenna to prevent excessive loading of the oscillator by the antenna. It also serves as a high-level stage for amplitude modulation. The plate circuit of the power amplifier is resonated by transformers covering the frequency bands of the target transmitter. The secondary windings of these transformers couple into the antenna tuning network.

c. Audio Oscillator and Modulator. Audio oscillator and modulator circuit V603, another type 6AK6, produces a 1,000-cps af voltage which is fed to power amplifier V602 when an amplitude-modulated signal is desired. Switch S604 turns the modulation on or off by closing or opening the cathode of V603.

d. Rectifier and Power Supply. The high-voltage (180 volts) direct current required for the B+ of the target transmitter is furnished by full-wave rectifier V604, a type 5Y3GT.

e. Battery Power Supply. A battery power supply may be used when the target transmitter must be carried out to the antenna array away from the source of 115-volt ac power. Switch S603 disconnects the ac power supply filter circuit and simultaneously connects the B- and A- batteries into the target transmitter power supply leads. Two 90-volt dry batteries in series furnish the B+ and one 6-volt dry battery supplies the heaters of the target transmitter.

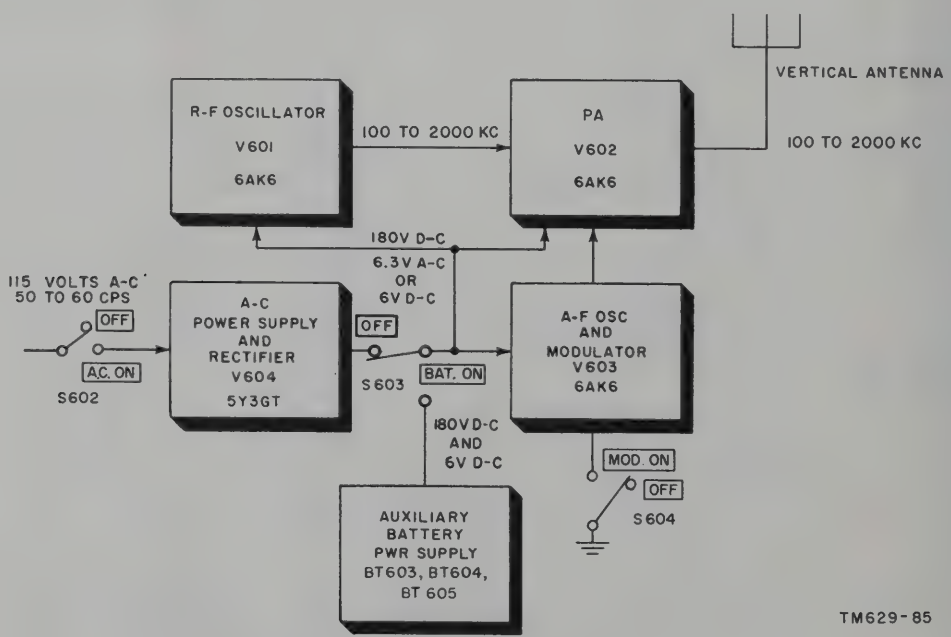


Figure 66. Target transmitter, block diagram.

109. RF Oscillator V601
(fig. 94)

The RF oscillator stage uses a pentode type 6AK6 tube in a tuned plate oscillator circuit. This circuit will oscillate on any selected frequency between 100 and 2,000 kc. This frequency range is divided into three overlapping bands: band 1, 100, to 270 kc; band 2, 260 to 720 kc; and band 3, 720 to 2,000 kc. These bands are changed by BAND SWITCH S601, a four-section rotary switch which uses two of its sections to select RF oscillator transformer T601, T602, or T603 for the particular band to be covered. Transformer T601 covers band 1, transformer T602 covers band 2, and transformer T603 covers band 3. The primary windings of the transformers are switched into the grid circuit of V601 by section 4, S601, and the secondary windings are switched into the screen grid circuit of V601 by section 3, S601. Tube V601 functions as a triode oscillator, the screen grid serving as the plate of the triode. The plate of V601 couples the oscillator signal to the next stage of the target transmitter by the development of a signal voltage across plate load resistor R603. Feedback is accomplished by the mutual coupling of the windings of transformers T601 through T603, whichever is switched into the circuit. This feedback voltage is coupled to the grid through C606, part of grid leak capacitor network R601 and C606. The proper negative bias for V601 is maintained by the accumulated charge on C606 from positive alternations of the signal voltage. The filter network composed of R606 and C607 serves to decouple the oscillator from the B+ supply at all operating frequencies and thereby prevents interaction with other circuits. Capacitors C602, C603, and C604, together with the slugs of transformers T601, T602, and T603, are used to set the operating limits of the tuned circuit of the RF oscillator for the particular bands used. Capacitors C619, C620, and C621 form part of the parallel resonant circuit of the individual transformers across which they are shunted. The RF oscillator is tuned to a particular frequency, within the band limits set by S601, by sections 3 and 4 of MAIN TUNING capacitor C601, which is ganged with the power amplifier output resonant circuit. The signal output of the RF oscillator is coupled to the grid of power amplifier V602 by capacitor C608.

110. Power Amplifier V602
(fig. 94)

a. Power amplifier V602 is used to amplify the signal voltage developed by RF oscillator V601. It also serves to isolate the antenna circuit from the oscillator stage. Changes in antenna loading caused by the presence of personnel or objects near the antenna will not affect the output frequency of the target transmitter because of this isolation.

b. Power amplifier tube V602 is a pentode-type 6AK6 operating as a screen-modulated class A amplifier. The plate circuit of V602 is resonated by means of transformers T606, T605, and T604 together with parallel sections 1 and 2 of capacitor C601. Transformers T606, T605, and T604 are slug-tuned to set the limits of their operating ranges. The transformers are selected for the individual bands by means of sections 1 and 2 of BAND SWITCH S601. Resistor R602 is the grid return for V602. Resistor R608 is the screen grid dropping resistor; it also limits screen current regardless of the setting of R619. Resistor R619 serves as a voltage divider for adjusting the amplitude of the modulation voltage received from V603. Capacitor C618 is the screen RF bypass capacitor for V602. Capacitor C617 is the plate RF bypass capacitor which prevents RF currents from entering other circuits through the B+ lead.

c. The antenna circuit is peaked by means of shunt capacitor C610, which reduces the reactive component of the whip antenna. Tuning indicator I601 is a neon lamp which indicates when maximum signal voltage is developed across C610 (maximum antenna current). The antenna output is taken from J602, the socket into which the five-section whip antenna is fitted.

111. Audio Oscillator and Modulator V603
(fig. 94)

a. Audio oscillator V603 is a pentode-type 6AK6 tube used to develop a 1,000-cps audio signal for modulating the RF output of the target transmitter. Oscillations are sustained by the feedback in the mutual coupling of the windings of transformer T612.

b. The frequency of oscillation (approximately 1,000 cps) is determined by the plate-tuned circuit consisting of capacitor C617 and the primary (pins 1and 2) of T612 and its distributed capacity. The feedback necessary to sustain oscillation occurs

through the mutual inductance between the primary and secondary windings of T612. Resistors R605 and R607 form a voltage divider in the secondary circuit of T612, with the grid drive voltage being taken across R605. Bias for the oscillator is obtained by means of a grid-leak arrangement consisting of resistors R605 and R607 and capacitors C616 and C622. Capacitor C615 offers a low-impedance path to ground for harmonics present in the grid circuit. Resistor R604 is the screen dropping resistor and C609 is the screen bypass capacitor. The oscillator output appearing at the plate is applied across OUTPUT control R619 and is fed to the screen grid of power amplifier V602 through screen dropping resistor R608. The oscillator is turned on and off by means of the MOD. switch S604 which opens or closes the cathode circuit to ground.

112. Rectifier V604
(fig. 94)

a. The ac power supply, consisting of the ac input circuit, transformer T611, rectifier V604, and the filter section, is used when the target transmitter can be utilized near a source of 115-volt ac power.

b. The 115-volt 50- to 60-cycle ac power is applied through connector J601, a male four-contact plug. A power cord is used with this chassis-mounted plug so that the transmitter can be connected to an ac outlet. A. C. switch S602 applies or disconnects the ac power. Fuses F601 and F602 are used to protect the circuits of the target transmitter (particularly the power transformer T611) from damage in case of shorts or overloads. A pi-type filter section, consisting of L601, L602, L603, and L604, together with capacitors C611 and C612, prevents noise and RF voltages, which may be present in the power line, from affecting the operation of the target transmitter.

c. Power transformer T611 steps up the 115-volt ac input to 225 volts ac. This voltage is rectified by full-wave rectifier circuit V604. A 5-volt winding of T611 supplies V604 with filament power, and a 6.3-volt winding furnishes heater voltage for the other tubes in the target transmitter. The B+ voltage is taken off V604 filament and passed through a filter section consisting of L611, C613, and C614, which smoothes the pulsating dc supplied by the rectifier into dc with a low ripple content. Resistor R622 serves as a bleeder resistor for the power supply and discharges the filter capacitors when the power is turned off.

113. Battery Power Supply
(fig. 81)

a. When the target transmitter is used to check antenna alinement no source of 115-volt power normally will be present. The battery supply must then be used.

b. BAT. ON switch S603 disconnects the B+ and heater circuits of the target transmitter from the ac power supply output circuit, and connects batteries BT603 and BT604 to supply B+, and BT605 to supply the heater voltage to the circuits of the transmitter. Batteries BT604 and BT603 connect to the target transmitter by means of plugs P604 and P603. Battery BT605 connects to the transmitter by means of plug P605. The batteries have integral receptacles for the plugs described above. The target transmitter contains the batteries in a special carrier within the transmitter case.

c. PWR. IND. I 602, a neon lamp assembly with an internal voltage dropping resistor, indicates when the B+ voltage is applied to the target transmitter. It functions either with the battery supply voltage or with the 115-volt ac power supply voltages (par. 112).

Section VIII. THEORY OF POWER DISTRIBUTION AND CONTROL CIRCUITS

114. General

The direction finder set is powered from a source of 115-volt ac power, with a line frequency of 60 cps. The power source may be either a commercial source or the power unit. If the direction finder set is located so that commercial power is continually available, the power unit can be considered an emergency source of power, and kept ready for use at all times in the event of failure of the commercial source. If a source of 230-volt 60-cps ac power is available, it will be possible to operate the direction finder set by means of the stepdown feature of the junction box. However, it will be necessary to connect the shelter circuit to ground and one leg of the 230-volt source. *Never operate the direction finder set from a direct current power source.*

115. Block Diagram of Power Distribution (fig. 67)

a. Power is brought into the shelter by a heavy rubber-covered power cable (W812), which is 300 feet long, and connected to the terminal box by means of the wingnut terminals inside the box. The inside terminals are arranged so that all circuits are connected in parallel. Cable W815, connected to another pair of terminals in the terminal box, distributes power to the junction box which supplies all operating components in the shelter with 115-volt 60-cps ac power. The 115-volt ac output of the junction box is connected to the azimuth indicator by cable W813. The azimuth indicator serves as a distribution point for ac power for the goniometer drive, through cable W814, and for the receiver, through its own power cord.

b. Power for the shelter components and auxiliary circuits is distributed by the shelter circuit switch. The primary power is connected to the shelter circuit by means of cable W816. Permanently installed conduit in the shelter distribution system carries the ac power to the convenience outlets. Power for the heater, blower, and shelter illumination is taken from the convenience outlets.

116. Junction Box J–95B/CRD–2

The junction box is used to control the input power to the direction finder set. It also is used to select the operating voltages from available commercial or power unit sources and to monitor the power line frequency. The schematic diagram of the junction box is shown in figure 89, and the wiring diagram is shown in figure 95.

a. During 115-volt operation, the input is connected through plug P902 which, in turn, is connected to section B of LINE INPUT switch S901. With this switch in the 115V position, input power is connected through circuit breaker K902 and appears across one-half of the winding of transformer T901.

b. Connection from the 230-volt ac source is made to connector P901 which, in turn, is connected to LINE INPUT switch S901A. With S901A in the

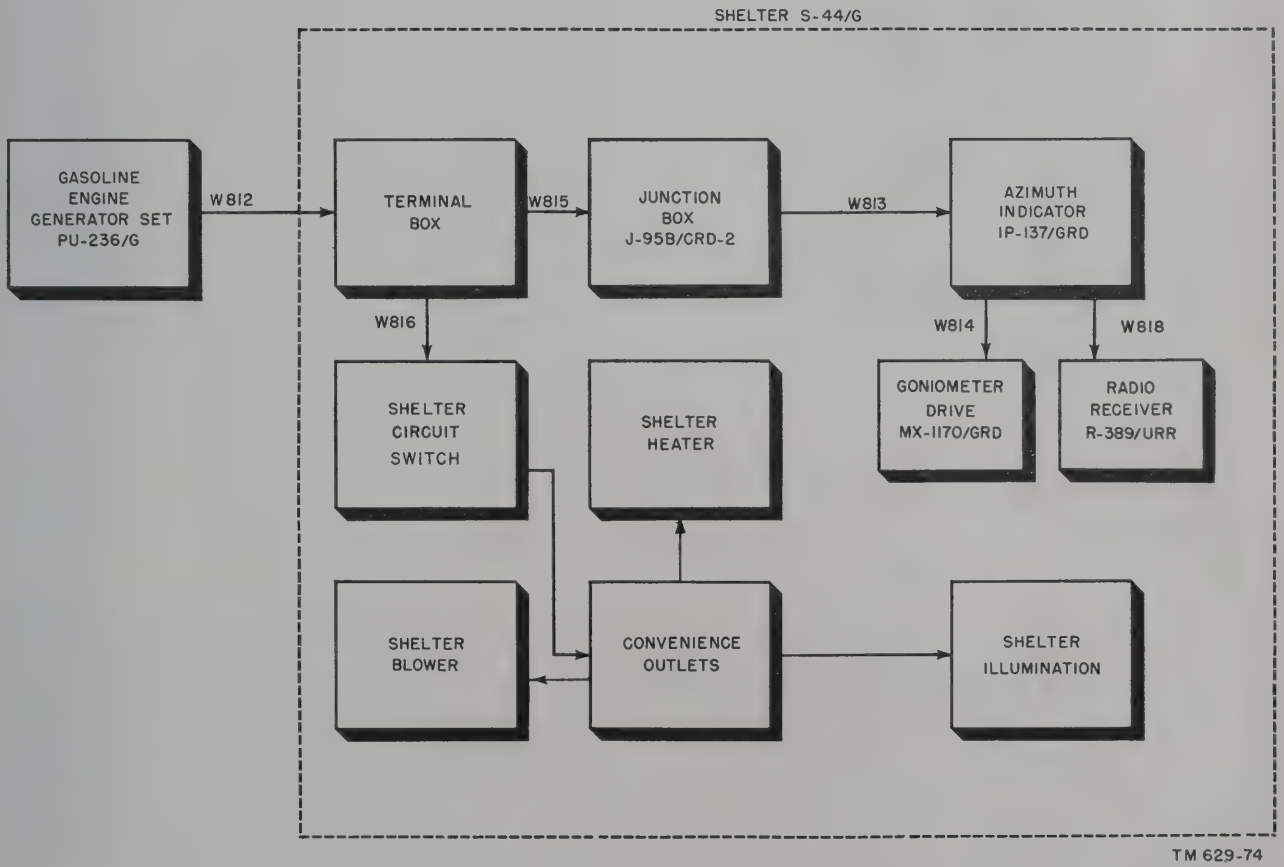


Figure 67. Power distribution of direction finder set, block diagram.

230V position, input power is applied across the entire winding of autotransformer T901. Circuit breaker K901 is connected in series with one side of this winding to protect the circuit from overload.

Caution: Before operating the direction finder set from 230-volt 60-cycle ac power, always connect the shelter circuit ground and to one leg of the 230-volt ac source to prevent damage to the shelter power system.

c. Autotransformer T901 provides taps which permit operation from 96, 101, 106, 112, 117, 122, 125, 132, 137. Switch S902 is a nine-position switch which permits adjustment of the ac output voltage.

d. Meter M901 is a 0- to 150-volt ac meter which indicates the output voltage of the junction box.

e. Meter M902 is a read-type frequency meter with a 55- to 65-cycle range. It indicates the frequency of the output current of the junction box.

f. Resistors R901 through R904 are dummy load resistors which serve as a load while making preliminary adjustments to allow the line voltage to be adjusted to 115 volts before it is applied to the operating components.

117. Operating Components Power Circuits
(figs. 29, 31, and 67)

a. Power from the junction box enters the azimuth indicator over cable W813 (fig. 31) through connector P302.

b. The receiver gets power from MAIN POWER switch S303 through connector J305 over the power cable supplied with the receiver.

c. The azimuth indicator receives power from S303 and INDICATOR switch S304.

d. The goniometer drive gets power through S303, S304, GONIO-DRIVE switch S302, connector J304, cable W814, and goniometer drive connector P701.

e. Refer to the power distribution block (fig. 67) for additional information and detailed circuit connections.

CHAPTER 6

FIELD MAINTENANCE

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: When servicing the direction finder set, be extremely careful of high voltages. Keep one hand in your pocket when measuring high voltages. Before touching any part after the voltage is turned off, short the part to ground. Read the caution notices in the individual equipment manuals before attempting repair.

118. General Instructions

Troubleshooting at field and depot maintenance level includes all the techniques outlined for organizational maintenance and any special or additional techniques required to isolate a defective part. The field and depot maintenance procedures are not complete in themselves but supplement the procedures described in organizational maintenance. The systematic troubleshooting procedure, which begins with the operational and sectionalization checks that can be performed at an organizational level, must be completed by means of sectionalizing, localizing, and isolating techniques. Paragraphs 121 through 124 provide *interunit* troubleshooting procedures which must be performed at the field maintenance level; paragraphs 125 through 139 describe *intra-unit* (within the unit) localizing and isolating techniques that must be performed at a field maintenance level. When troubleshooting the power unit, the receiver, the shelter, and the telephone, refer to the appropriate technical manuals listed in paragraph 1*b*.

119. Troubleshooting Procedures

a. General. The procedure in servicing a defective direction finder set is to sectionalize the fault. Sectionalization means tracing the fault to a major component or circuit responsible for abnormal operation. Second localize the fault. Localization means tracing the fault to a defective part responsible for the abnormal condition. Some faults, such as burned out resistors, arcing and shorted transformers can often be located by sight, smell, and hearing. The majority of faults, however, must be localized by checking voltages and resistance.

b. Sectionalization. Listed below is a group of tests arranged to reduce unnecessary work, and to aid in tracing trouble in a defective direction finder set. Direction Finder Set AN/TRD–3 consists of four units—the receiver, the azimuth indicator, the goniometer drive, and the junction box. Locate the unit or units at fault by the following methods:

(1) *Visual inspection.* The purpose of visual inspection is to locate faults without testing or measuring circuits. All meter readings, scope patterns, or other visual signs should be observed and an attempt made to sectionalize the fault to a particular unit.

(2) *Operational tests.* Operational tests frequently indicate the general location of trouble. In many instances, the tests will help in determining the exact nature of the fault. The equipment performance checklist (par. 74) is a good operational test.

c. Localization. The tests listed below will aid in isolating the trouble. First, localize the trouble to a single stage or circuit, and then isolate the trouble within that circuit by voltage, resistance, and continuity measurements. Use the following methods of trouble localization:

(1) *Voltage and resistance measurements.* These measurements will help locate the individual component part at fault. Use resistor and capacitor color codes (figs. 86 and 87) to find the value of the components. Use voltage and resistance diagrams (figs. 77 and 82) to find normal readings, and compare them with readings taken.

(2) *Troubleshooting chart.* The symptoms listed in the charts (pars. 122, 127, 130,

and 131) will aid in localizing trouble to a component part.

(3) *Intermittent troubles.* In all these tests, the possibility of intermittent troubles should not be overlooked. If present, this type of trouble often may be made to appear by tapping or jarring the equipment. Check the wiring and connections to the units of the direction finder set.

(4) *Signal substitution.* Signal substitution procedures enable the repairman to localize a trouble quickly to a stage. A signal generator, audio oscillator, and oscilloscope may be used in signal substitution procedures.

120. Test Equipment Required

The following chart lists test equipment required for troubleshooting the direction finder set, the associated technical manuals, and the assigned common name.

Test equipment	Technical manual	Common name
Signal Generator AN/URM–25.	TM 11–5551	Signal generator
Electron Tube Test Set TV–2/U.	TM 11–2661	Tube tester
Multimeter TS–352/U	TM 11–5527	Multimeter
Oscilloscope OS–8A/U	TM 11–1214	Oscilloscope
Electronic Multimeter TS–505/U.	TM 11–5511	Vtvm
Frequency Meter AN/URM–79.	TM 11–5094	Frequency meter

Section II. TROUBLESHOOTING GONIOMETER DRIVE AND GONIOMETERS

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraphs 133 and 134.

121. Test Setup

(fig. 30)

Bench tests of the goniometer drive require connection to a power source. The power source must be connected from the azimuth indicator to the goniometer drive for all dynamic-servicing procedures. Remove the goniometer drive from the rack (par. 133) and make a test setup as outlined below.

a. Power Supply Connections.

(1) The power unit, which furnishes power to the direction finder set through the junction box, is the most convenient power source for use in bench tests. If it is available, connect power to the goniometer drive from the azimuth indicator through Cable CX–3330/U.

(2) If power from the power unit is not available, use an equivalent power source capable of supplying 100 watts at 115 volts ac, 50 to 60 cycles per second.

b. Signal and Indicator Goniometer Connections. To troubleshoot the signal and indicator goniometers, make all the connections as outlined in paragraph 39.

122. Localizing Troubles

a. General. Procedures are outlined in the following chart for localizing troubles to the goniometer drive motor, signal goniometer or indicator goniometer. Parts location is indicated in figures 68, 69, and 70. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in the localization of trouble to a particular unit, use the techniques outlined in paragraph 133 to make the necessary repair.

b. Use of Chart. The troubleshooting chart is used to supplement the operational checks detailed in the equipment performance checklist (par. 74). If previous operational checks have resulted in reference to a particular item of this chart, go directly to that item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist and proceed until the trouble is located.

c. Conditions for Tests. All checks outlined in the chart are to be performed with the goniometer drive connected as described in paragraph 39.

d. Troubleshooting Chart.

Note. Perform the operations in the equipment performance checklist before using this chart, unless trouble has already been localized.

(1) *Goniometer drive.*

Item	Indication	Probable trouble	Procedure
1	Lamp E701 and E702 does not light.	Defective lamp.	Replace lamp.
2	Motor does not operate.	Defective starting capacitor C701.	Replace capacitor.
		No power from azimuth indicator.	Refer to paragraph 136.
		Fuse F301 in azimuth indicator is open.	Replace fuse.
		Defective motor.	Replace motor.
		Frozen goniometer bearing.	Replace bearing (par. 135).
3	Pattern rotates in one direction.	Goniometer not keyed to drive.	Press finger into hole at end of goniometer and rotate azimuth scale until click is heard indicating that plunger has fallen into slot to insure positive drive (fig. 70).

(2) *Indicator and signal goniometers.*

Item	Indication	Probable trouble	Procedure
1	Sense pattern interrupted on indicator or pattern becomes ragged.	Vibration of the contacts of sense relay K541 cause intermittent connection of sense circuit to goniometer (fig. 69).	Adjust contact alinement of sense relay; clean and burnish contacts (par. 140).
2	No sense pattern.	When trouble has been sectionalized to goniometer, it may be caused by an open or grounded circuit.	Inspect and repair wiring.
		Defective relay.	Replace relay.

123. Dc Resistances of Transformer and Coils in Goniometer GO–5/GRD

The dc resistances of the transformer windings and the coils of the indicator goniometer are as follows:

Transformer or coil	Terminals	Resistance (ohms)
L401	J401–J402	Less than 1
L402	J403–J404	Less than 1
T401	Pins of J405	Less than 1

124. Dc Resistances of Transformer and Coils in Goniometer GO–9/TRD–3

The dc resistances of the transformer windings and the coils of the signal goniometer are as follows:

Transformer or coil	Terminals	Resistance (ohms)
L541	J541–J542	Less than 1
L542	J543–J544	Less than 1
L543	Across coil	Less than 1
T541	Pins J545	Less than 1

Section III. TROUBLESHOOTING AZIMUTH INDICATOR IP–137/GRD

Caution: Do not attempt removal or replacement of parts before reading the instructions in paragraph 136.

125. Checking Filament and B+ Circuits for Shorts

a. When to Check. When any of the following conditions apply, check for short circuits and clear the troubles before applying power.

(1) When the azimuth indicator is being serviced apart from the other units of the direction finder set and the nature of the abnormal symptoms is not known.

(2) When abnormal symptoms reported from operational tests indicate possible power supply troubles (items 29 and 30 of the equipment performance checklist (par. 74)).

b. Conditions for Tests. To prepare for the short-circuit tests, perform the following steps:

(1) Disconnect the cables from the azimuth indicator.

(2) Remove the azimuth indicator from the rack (par. 136).

(3) Remove all tubes.

(4) Set the MAIN POWER switch to ON.

(5) Set the INDICATOR switch to ON.

(6) Set the GONIO-DRIVE switch to ON.

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is found, repair the trouble before applying power to the unit.

Short-circuit tests

Point of measurement	Normal indication	Isolating procedure
Either pin of Plug 302 and ground.	Infinite resistance.	None
Pin 8 of Tube V305 and ground.	150 k	Check capacitor C327.
Pin 3 or 6 of tube V306 and ground.	1 meg.	Check capacitor C331.
Pin 1 or 5 of tube V310 and ground.	1 meg.	Check capacitors C319 and C320.

126. Test Equipment

a. If the azimuth indicator is connected to its associated components as in normal operation, operate the equipment as described in the equipment performance checklist (par. 74). This checklist, when followed, frequently indicates the general location of trouble.

b. The azimuth indicator can be checked apart from its associated components by the following procedure.

(1) Connect an indicator goniometer to connectors J307, J308, J310, and J311 on the rear of the chassis (fig. 29). Use cords and connectors indicated in figure 31.

(2) Connect a 115-volt, 50- or 60-cycle ac power source to P302 and turn on and test the equipment in accordance with instructions outlined in the equipment performance checklist (par. 74).

(3) A diametral line 4 inches long (with less than one-half setting of the SIZE control) will appear if the equipment is functioning properly and the line will rotate as the indicator goniometer is rotated. Also, when the sense switch is depressed, the line will change to a radial line.

(4) Connect the signal generator (Signal Generator AN/URM–25), set at 455 kc, to J302 on the rear of the chassis. This signal will reduce the length of the line and change it to a dot which checks the operation of the IF amplifier and detector circuits.

127. Localizing Troubles

a. General. Procedures are outlined in the following chart for localizing troubles to the IF, RF, power supply and video sections of the azimuth indicator, and for localizing troubles to a stage within the various sections. Parts location is indicated in figures 72, 73, and 74. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary.

b. Use of the Charts. The troubleshooting chart is used to supplement the operational checks detailed in the equipment performance checklist (par. 74). If previous operational checks have resulted in reference to a particular item of this chart, go directly to the referenced item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist and proceed until the trouble is located.

Caution: If operational symptoms are not known, or they indicate the possibility of short circuits within the azimuth indicator, make the short-circuit checks described in paragraph 125 before applying power to the unit.

c. Conditions for Tests. All checks outlined in the chart are to be conducted with the azimuth indicator connected to a power source as described in paragraph 39.

d. Troubleshooting Chart for Azimuth Indicator.

Note. Perform the operations in the equipment performance checklist before using this chart, unless trouble has already been localized.

Item	Symptom	Probable trouble	Procedure
1	No pattern (cathode-ray tube dark) sound normal, dial lamps on.	Low or zero B+ voltage.	Check voltage and resistances at tube socket contacts of rectifier tube V305, regulator tube V306, oscillator V309, and high-voltage rectifier V310.
		High-voltage rectifier tube V310 defective.	Replace tube.
		High voltage not supplied to pin 2 of cathode-ray tube V304.	Check for −2,000 volts at junction of resistors R334 and R335; and pin 1 of high-voltage supply (at terminal strip on bottom of oscillator).
		Cathode-ray tube V304 defective.	Replace.
		RF oscillator tube V309 defective.	Replace.
2	No sound, pattern normal.	Disconnected or defective cable W302 to speaker.	Repair or replace cable.
		Defect in direction finder receiver.	Refer to receiver trouble-shooting chart.
		Defective speaker LS301 to transformer T308.	Replace.
3	No pattern, dial lights off, sound normal, goniometer drive motor normal.	No power to transformer T306.	Check fuse F302 in indicator. If open, replace with 1.25-ampere Bussman SLO-BLO fuse. *Note.* A standard 1.25-ampere fuse will not take the starting surge.
4	No sound, circular pattern.	Defective receiver.	Refer to receiver trouble-shooting chart.
		Faulty signal goniometer.	Replace goniometer.
		Defective signal goniometer to receiver cable W811.	Repair or replace cable.
5	Inaccurate bearings.	Damaged antenna cable W801, W802, W803, or W804.	Replace defective cable with matched spare cable.
		Accidental ground in signal or indicator goniometer or connecting cables to produce unbalance.	Check resistance to ground.
		SHAPE control improperly adjusted.	Refer to operating instructions.
6	Goniometer drive does not operate. Power source normal. Straight line pattern under no signal condition.	Fuse open (F301).	Replace with time lag fuse Littelfuse SLO-BLO 1.6 amperes. *Note.* A standard 1-ampere fuse will not take the starting surge.
7	Circular pattern only, sound normal.	Defective input IF cable from receiver to indicator (W805) or loose cable connection.	Tighten or replace cable.
		Indicator IF (V301) amplifier defective.	Replace tube. Check voltage and resistance at tube sockets.
		Defective detector stage (CR301, CR302, or CR303).	Replace.
8	Erratic pattern, sound normal.	Rectifier CR301 defective; loose IF cable W303 connection.	Tighten or replace.
9	Propeller not sharp at tip, sound normal.	Rectifier CR302 and CR303, defective.	Replace.

Item	Symptom	Probable trouble	Procedure
10	Dot pattern only in center of screen, sound normal.	Indicator to indicator goniometer cable defective or loose connection.	Replace or tighten cable.
		Control modulator tube (V302) defective.	Replace.
		RF amplifier tube (V303) defective.	Replace.
		Defective signal or indicator goniometer.	Replace.
		RF GAIN control on receiver set up too high.	Reduce RF gain.
11	Under no signal conditions stationary straight line pattern north and south or east and west.	Loose connection in one of indicator goniometer-to-indicator cables W806, W807, W808, and W909.	Tighten cable.
		One in indicator goniometer stator open. Worn contacts in switch S301 sections 1 or 2.	Replace goniometer.
12	Signals from all directions indicate same bearing.	Loose connections in one of four goniometer-to-indicator cables.	Tighten cable.
		Worn contacts in switch S301 section 1 or 2.	Replace switch.
		One-half of antenna disconnected because of loose cable connection.	Tighten cable.
13	Bearings from all directions off by same amount in same direction.	Improperly oriented signal goniometer.	Orient goniometer with antenna (par. 59).
		If using aural-null operation improperly oriented index mark.	Orient goniometer with antenna (par. 59).
14	No sense pattern. Signal pattern normal, sound normal.	Signal goniometer relay K541 inoperative (listen for click).	Refer to goniometer trouble-shooting chart (par. 122).
		Defective sense switch S301.	Replace.
15	Double propeller pattern when sense switch is depressed. Sound normal.	Defective blanking circuit, rectifier CR304.	Replace.
		Improperly adjusted SENSE PHASING potentiometer R340.	Readjust, refer to alignment procedure (par. 143).
16	Bearing error which varies with different bearing readings.	Unbalance in antenna caused by poor electrical connection at any of mast connections, ground connections, cable connectors, or damaged cable.	Inspect all connections and tighten. If error prevails substitute a new antenna cable between one of antenna masts and signal goniometer. Try each antenna in turn using new cable.
17	Bearing error, maximum at 45°, 135°, 225°, or 315°.	Unequal amplitude from pair of antennas.	Check cable connections.
		Loose ground.	Inspect for poor connection and tighten.
		Defective antenna coupler (fig. 85).	With an ohmmeter, check resistance of coils and resistors. Resistance of similar components in all four couplers must match within 1 percent.
18	Bearing appears in wrong quadrant.	Antenna cables reversed at antenna, at goniometer or at rear of azimuth indicator.	Connect cables properly.
19	Bearings shift with receiver tuning.	Receiver selectivity setting too sharp.	Set selectivity to 2-kc bandwidth.
		Regeneration in the receiver IF system.	Check for defective parts in receiver IF system.
			Aline receiver; refer to receiver manual.

Item	Symptom	Probable trouble	Procedure
20	When goniometer drive azimuth scale is rotated, propeller pattern does not follow accurately.	Improper voltage on horizontal and vertical deflection plates.	Readjust shape control. Retune horizontal and vertical deflection transformers T305 and T304. Refer to paragraph 189. Substitute a new indicator goniometer and, if error persists, substitute a new cathode-ray tube.
21	Weak or indefinite sense pattern.	Defective sense phasing switch in signal goniometer.	Replace switch.
22	Pattern rotates in one direction.	Signal or indicator goniometer is not properly keyed to drive.	Refer to goniometer trouble-shooting chart (par. 122).
23	Rotating alidade shifts pattern.	Static charge on screen.	Refer to paragraph 137.

128. Dc Resistances of Transformers and Coil in Azimuth Indicator IP–137/GRD

The dc resistances of the transformer windings and the coil of Azimuth Indicator IP–137/GRD are as follows:

Transformer or coil	Terminals	Resistance (ohms)
L301	A–D	12
T301	C–B	Less than 1
	A–D	12
T302	1–2	11.5
	3–4	15.25
T303	1–2	Less than 1
	3–4	Less than 1
T304	1–2	Less than 1
	3–4	21
	6–7	21
T305	1–2	Less than 1
	3–4	21
	6–7	21
T306	1–2	Less than 1
	3–4	46
	4–5	46
	6–7	Less than 1
	7–8	Less than 1
	9–10	Less than 1
	11–12	Less than 1
T307	1–2	2.3
	3–4	420
	Red–Red	Less than 1
T308	1–2	23
	3–4	Less than 1

Section IV. TROUBLESHOOTING JUNCTION BOX J–95B/CRD–2

129. General Precautions

Be careful not to touch the 115- or 230-volt terminals when working on the junction box. When tests are completed, immediately remove the power.

130. Localizing Troubles

a. General. Procedures for localizing troubles to the junction box are outlined in the following chart. Parts location is indicated in figure 84. One or more of the localizing procedures will be necessary, depending on the nature of the operational symptoms. When use of the procedures result in the localization of trouble to a particular part, use the techniques outlined in paragraph 139 to make the necessary repair.

b. Use of Chart. The troubleshooting chart is used to supplement the operational checks detailed in the equipment performance checklist (par. 74). If previous operational checks have resulted in reference to a particular item of this chart, go directly to that item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist and proceed until the trouble is located.

c. Conditions for Tests. All checks outlined in the chart are to be conducted with the junction box connected to a source of 115 volts ac, 60 cps to receptacle P902. Use the multimeter and perform the following items in numerical sequence.

d. Troubleshooting Chart.

Note. Perform the operations in the equipment performance checklist before using this chart, unless trouble has already been localized.

Item	Symptom	Probable trouble	Procedure
1	Meters M901 and M902 do not indicate voltage and frequency of power source.	Open circuit breaker K902. Contacts of S902 defective. Defective meters. Short circuit across output load. Transformer T901 has open winding.	Press button marked 115V. Replace S902. Replace meters. Locate and repair short. Replace T901.
2	Meters indicate normally when switch S903 is set at DUMMY position but no voltage is present at receptacles J901 through J905 when set at EQUIPMENT position.	Defective switch contacts.	Replace S903.
3	Normal conditions obtained with 115-volt power input to P902; no voltage is indicated when 230-volt power is connected to P901. (Switch S901A set to the 230 V position.)	Open circuit breaker K901. Contacts in S901A defective. Open winding in transformer T901.	Press reset button marked 230V. Replace S901A. Replace T901.
4	Normal conditions obtained with 230-volt power input to receptacle P901; no voltage is indicated when 115-volt power source is connected to receptacle P902 (switch S901B set to the 115 V position).	Open circuit breaker K902. Contacts in S901B defective. Open winding in transformer T901.	Press reset button marked 115 V. Replace S901B. Replace T901.
5	Voltmeter fluctuates.	Fluctuating input from source. Defective input receptacles P901, P902. Defective output to receptacles.	Check input line back to source. Replace P901, P902. Replace defective output receptacles.

Note. When circuit breaker K902 does not remain closed after it has been reset, an overload condition is indicated and could be caused by a shorted transformer T901 or a short circuit within the junction box.

Section V. TROUBLESHOOTING IN RADIO TRANSMITTER T–339/UR

131. Localizing Trouble

a. General. Procedures are outlined in the following chart for localizing troubles in the transmitter. Parts location is indicated in figures 79 and 80. Depending on the nature of the operational symptoms, one or more of the localizing procedures will be necessary. When use of the procedures result in localization of trouble to a particular part, use the techniques outlined in paragraph 138 to make the necessary repair.

b. Use of Chart. The troubleshooting chart is used to supplement the operational checks detailed in the equipment performance checklist (par. 74). If previous operational checks have resulted in reference to a particular item of this chart go directly to that item. If no operational symptoms are known, begin with item 1 of the equipment performance checklist and proceed until the trouble is located.

c. Conditions for Tests. All checks outlined in the chart are to be conducted with the transmitter connected as described in paragraph 39. Use the vtvm and receiver and perform the following items in numerical sequence.

d. Troubleshooting Chart for Transmitter.

Note. Perform the operations in the equipment performance checklist before using this chart, unless trouble has already been localized.

Item	Symptom	Probable trouble	Procedure
1	PWR. IND. lamp does not light.	Defective lamp.	Replace lamp.
		Defective power source.	Check batteries.
		Defective ac power supply.	Check rectifier V604.
		Defective cord or connector.	Check J601 for defective contacts. Check power cord.
		Fuse open.	Check F601. Replace.
		Defective power transformer.	Check T611 for defective winding. Replace T611.
		Defective filter section.	Check L611. Replace if defective. Check C613 and C614. Replace if defective.
		Defective BAT. switch.	Check S603. Replace if defective.
2	No output signal on all bands.	Defective RF oscillator stage.	Check V601. Replace if low emission is evident.
		R606 open.	Replace.
		C607 has short in either section.	Replace.
			Check R601 and C606. Replace if defective.
			Check S601, sections 1 and 2 for poor contacts.
		Defective power amplifier stage.	Check V602. Replace if defective.
		R608 open.	Replace.
		R619 defective.	Replace.
		C618 shorted.	Replace.
		C608 open.	Replace. (Signal may be present but weak with open C608.)
			Defective switch S601, section 4 or 3. Replace or clean contacts.
			Winding of T612 open. Replace T612.
3	No output signal on one band.	Defective BANDSWITCH contacts.	Check S601 for defective contacts. Clean or replace S601.
		Defective transformer T601 through T606.	Locate defective transformer and replace. Make resistance checks of transformer windings.
4	RF output normal but no tone modulation.	Defective audio oscillator and modulator stage.	Check V603. Replace if defective.
			Check S604. Replace if defective.
			Check windings of T612. Replace if defective.
			Check C616, R607, R605, and C615. Replace if any component is defective.
			Check R604 and C609. Replace if defective.
5	Intermittent operation.	Defective tube.	Check tubes. Tap tubes gently to note intermittent operation from vibration.
		Defective capacitor.	Tap capacitors gently. Move leads to locate poor connection.
		Dirty switch contacts.	Clean all switch contacts.
6	Weak output.	Defective tube or tubes.	Check tubes for proper emission. Replace weak tube.
		Misalinement.	Realign. Refer to paragraph 146.

132. Dc Resistance of Transformers and Coils

The dc resistance of all transformers and coils in the transmitter are indicated in the following table.

Transformer or coil	Terminals	Resistance (ohms)
T601 or T604	1–2	14.5
	3–4	14.5
T602 or T605	1–2	4.6
	3–4	4.6
T603 or T606	1–2	1.7
	3–4	1.7
T611	1–2	14.4
	3–4, 4–5	583
	6–8	Less than 1
	9–10	Less than 1
T612	1–2	704
	3–4	46.4
L601		Less than 1
L602		Less than 1
L603		Less than 1
L604		Less than 1
L611		4.75

Section VI. REPAIRS

133. Repair of Goniometer Drive

(fig. 68)

To repair the goniometer drive chassis, the azimuth indicator chassis, or the receiver chassis, it is necessary to remove the chassis from its cabinet. Each chassis is firmly attached to its cabinet by front panel fasteners and by clamps placed to exert pressure on the chassis at various points. The clamp assembly bolts are painted red to aid in recognition of the clamping points. Replacement of worn out belts and drive disks require special repair procedures. The replacement procedures are given as follows.

a. Removal of Goniometer Drive Chassis (fig. 26).

(1) Remove the azimuth indicator rack from the top of the goniometer drive rack.

(2) Loosen the right hand vertical clamp and the right hand horizontal clamp. If necessary, loosen the three right hand vertical clamp retaining bolts.

(3) Loosen the left hand vertical clamp and the left hand horizontal clamp. If necessary, loosen the three left hand vertical clamp retaining bolts.

(4) Loosen the two top clamps which hold down the drive assembly casting.

(5) Loosen the retaining bolt that holds the V-shaped motor clamp. This bolt can be reached through the motor clamp wrench access and loosened with the spintite wrench which is located on the lid of the receiver and spare parts chest.

(6) Loosen the four knurled bolts on the goniometer drive front panel.

(7) Lift the motor clamp until it is clear of the motor brace and carefully slide the chassis forward a few inches.

(8) Remove the chassis.

b. Belts. To replace the belt, proceed as follows:

(1) Remove the cables from the signal goniometer, back off the knurled nuts that hold the goniometer to the housing, and remove the goniometer.

(2) Remove the belt first from the motor pulley and then from the drive pulley.

Note. Pull the belt through the opening exposed by removing the signal goniometer.

(3) Insert a new belt through the same opening.

(4) Install the new belt first over the drive pulley, and then over the motor pulley.

(5) The belt tension should be such that grasping the belt at a point midway between the pulleys and moving it up and down produces about 1-inch deflection. If a change is necessary, the four mounting bolts underneath the chassis must be loosened. The adjustment screw on the rear of the chassis is then adjusted to slide the motor forward or backward as desired. The mounting bolts must then be tightened.

(6) Replace the signal goniometer and cables.

Note. A countersunk hole in the end of the goniometer body makes it possible to touch the end of the goniometer shaft. This hole is used to properly mate the plunger on the coupling to the slot in the drive disk. To do this, keep the goniometer shaft from rotating by pressing a finger against the shaft through the countersunk hole. With the other hand, rotate the azimuth scale until a click is heard. This indicates that

the plunger has fallen into the slot and is properly mated. If the azimuth scale cannot be rotated without rotating the shaft, the plunger is already in the slot.

c. Drive Disk.

(1) Remove both goniometers.

(2) Insert a screw driver into the center of the drive pulley and unscrew the retaining screw that holds the two drive disks together.

(3) Remove the drive disks. The drive disks are similar, but the left disk has a tapped hole through its center and the right disk has a clearance hole (fig. 68).

(4) To install the replacement disks, face the slotted face outward and locate the right and left disk on the proper sides. Replace the retaining screw.

Note. The centerline of the slot at its outer end must be lined up with 180° on the white scale.

d. Replacement of goniometer drive chassis.

(1) Slide the chassis into the cabinet.

(2) Tighten the front panel bolts.

(3) Tighten all clamps.

(4) Tighten all clamp retaining bolts.

134. Repair of Electrical Goniometers

a. Sense Relay. Relay K401 or K541 will require occasional cleaning to insure satisfactory operation. Improper operation is indicated by a ragged or intermittent sense pattern on the indicator.

b. Relay Cleaning. To clean the relay, proceed as follows:

(1) Remove the left cover plate from the signal or indicator goniometer (fig. 69).

(2) Burnish the relay contacts with a burnishing tool. Clean the contacts with Cleaning Compound.

Caution: Never use emery cloth, sandpaper, or a file on the contacts.

(3) Check the operation and clean the contacts until a steady hash-free pattern is obtained. If cleaning does not correct the trouble, replace the relay.

(4) Replace the left cover plate.

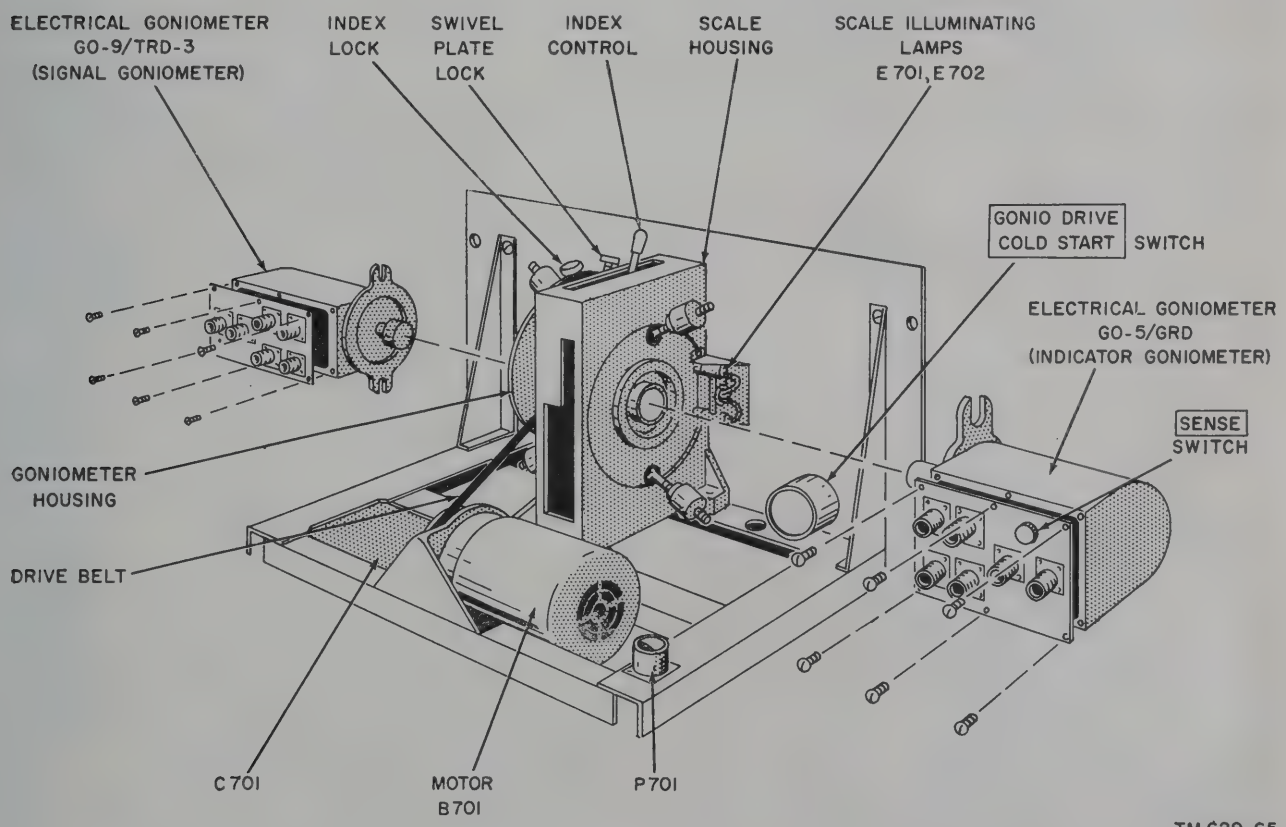


Figure 68. Goniometer drive assembly with electrical goniometers, exploded view.

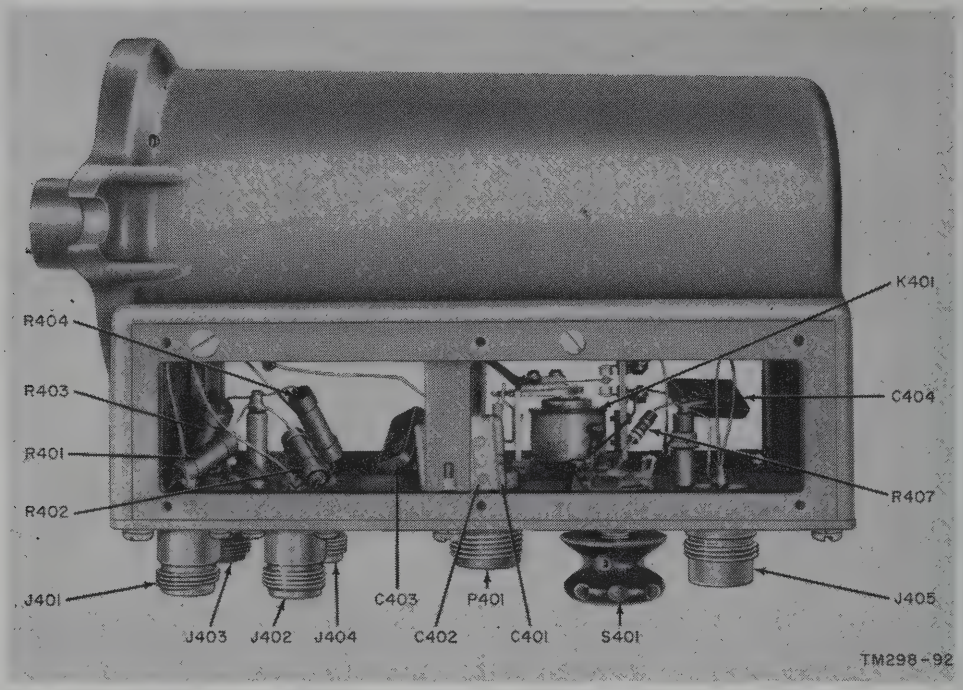


Figure 69. Electrical Goniometer GO–5/GRD, side view.

135. Replacement of Bearings in Signal or Indicator Goniometer

(fig. 70)

Note. Reference to goniometer applies to either the signal or indicator goniometer.

a. Rotor Removal.

(1) Loosen the four captive screws on the front panel of the goniometer drive (fig. 3) and pull the goniometer drive forward as far as possible.

(2) Remove the cables connected to the goniometer, back off the knurled nuts (fig. 68) that hold the goniometer to the goniometer drive housing, and remove the goniometer from the goniometer drive.

(3) With a pencil, mark a line on the end plate and on the goniometer housing. Remove the three flathead screws that hold the end plate to the goniometer housing (fig. 70).

(4) Grasp the coupling and pull the rotor of the goniometer from the goniometer housing.

b. Rear Bearing Replacement. Pull the rear bearing off the shaft and press the new bearing on the shaft. Replace the rotor. Use the line (*a*(3) above) as a guide to replace the end plate in its original position to retain the balance.

Caution: Do not pry the bearing off the shaft; if the bearing cannot be pulled off, use a bearing puller.

c. Front Bearing Replacement.

(1) Insert a punch in the small diameter hole in the coupling and remove the tapered locking pin.

Caution: The small diameter end of the tapered pin is adjacent to the Allen set screw. The punch must be inserted in this end to drive the tapered pin through the shaft and coupling.

(2) Use a No. 6 Allen wrench to loosen the Allen set screw.

(3) Pull the coupling off the shaft.

(4) Pull the end plate and front bearing off the shaft.

(5) Press the new bearing in the end plate. Replace the end plate and bearing on rotor shaft. Replace rotor. Use the line (*a*(3) above) as a guide to replace the end plate in its original position to retain the balance.

136. Repair of Azimuth Indicator

a. Remove the azimuth indicator chassis as follows (fig. 27):

(1) Loosen the right hand vertical clamp.

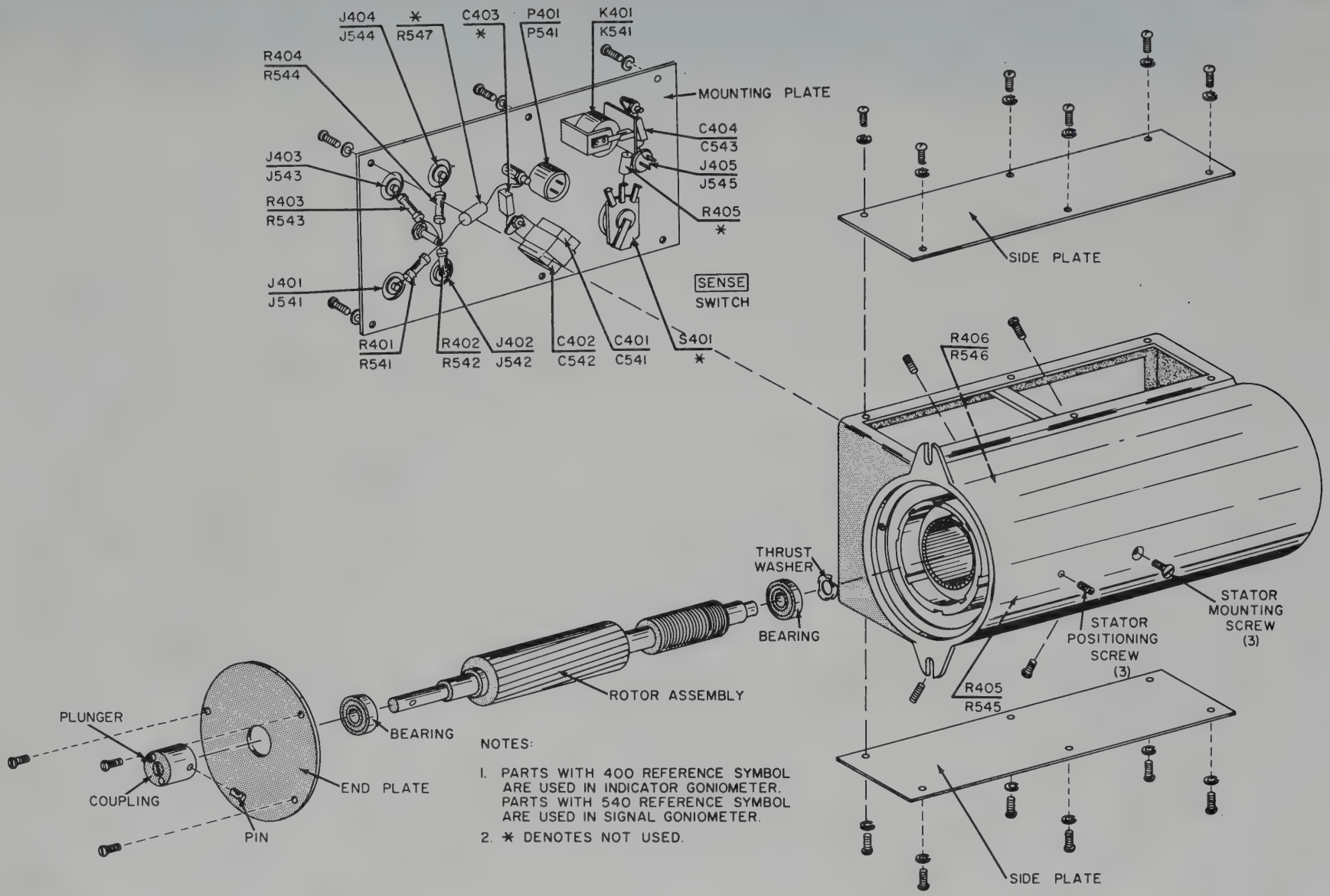


Figure 70. Goniometer, exploded view.

(2) Remove the four right hand vertical clamp retaining bolts and remove the right hand vertical clamp.

(3) Loosen the right hand horizontal clamp and the left hand horizontal clamp.

(4) Loosen the four transformer clamp retaining bolts and pull the transformer clamp up to clear the transformer. Lock the clamp by turning the locking rod.

(5) Loosen the four knurled bolts on the azimuth indicator front panel.

(6) Remove the chassis.

b. If the SENSE switch S301 (fig. 73) requires replacement, proceed as follows:

(1) Remove the bottom plate from the azimuth indicator.

(2) Loosen the two set screws that hold the SENSE switch handle and pull the handle out from the front.

(3) Remove four screws from the switch mounting flanges.

(4) Remove the switch as far as the harness will permit and unsolder the leads.

Note. Carefully mark or tag the wires connected to the switch to avoid misconnection when the new switch is installed.

(5) To replace switch S301, proceed as follows:

(*a*) Resolder the leads.

(*b*) Press in the switch and replace the mounting flanges.

(*c*) Replace four screws on the mounting flanges.

(*d*) Replace the SENSE switch handle and tighten the two set screws.

(*e*) Replace the bottom plate on the azimuth indicator.

c. To remove the cathode-ray tube, proceed as follows:

(1) Remove the alidade assembly by taking out three screws around the circumference (fig. 71). Pull or pry off the housing. Avoid marring the finish. It is not necessary to remove the lamp assembly (fig. 72).

(2) Disconnect the accelerating anode lead from the side of the tube.

(3) At the back of the tube, remove the connector cover by taking out two screws from the chassis.

(4) Remove the connector attached to the tube base.

(5) Wet the four grommets that support the tube face with soapy water on the tube may be broken during removal.

(6) Grasp the tube base with both hands and push the tube key at the socket with the thumbs until the tube is loose.

(7) Remove the tube through the front panel.

(8) To replace the tube proceed as follows:

(*a*) Replace the tube through the front panel. Be sure that the four grommets properly support the tube.

(*b*) Attach the connector to the tube base.

(*c*) Replace the connector cover and two screws.

(*d*) Connect the accelerating anode lead to the side of the tube.

(*e*) Replace the alidade assembly and fasten it with three screws. Check the alidade alinement (par. 137).

(9) The tube face should be as close as possible to the alidade assembly without interfering with the operation of the alidade. The tube may be shifted by turning the two knurled adjustments on the tube socket mounting.

d. To replace the azimuth indicator chassis, proceed as follows:

(1) Slide the chassis into the cabinet.

(2) Tighten the front panel bolts.

(3) Tighten the transformer clamp and the right hand and left hand horizontal clamps and clamp retaining bolts.

(4) Replace the right hand vertical clamp and the clamp retaining bolts.

(5) Tighten the right hand vertical clamp.

137. Alidade Friction Adjustment and Alinement

(fig. 71)

Adjust and aline the alidade rotating control as follows:

a. Remove the hood by taking out four screws and the lock knob.

b. Loosen the eight lock screws.

c. Tighten or loosen the adjusting screws until excess looseness or binding is eliminated.

d. Before locking the adjusting screws, check to see that the cross hairs have not been shifted to one side. The cross hairs are at right angles on a circular plastic screen. The screen is rotated by the alidade control. Alinement of the cross hairs is checked by taking reciprocal bearings. Bearings should be exactly 180° apart.

e. If the alinement is not correct, the cross hairs are shifted with the adjusting screws. For example, to shift the cross hairs to the left, loosen the left adjusting screws and tighten the right screws. Do not attempt to line up all four cardinal points at one time. Line up a cross hair with the 0° and 180° marks first. If there is 1° error, halve the difference, ½° at the 180° mark, then shift the cross hair to one side until there is no error. Repeat this operation for the 90° and 270° cross hairs, shifting the cross hair up or down as required. Tighten the locking screws when the cross hairs are properly alined and rotate freely.

f. When it is evident that rotating the alidade causes a shift in the pattern, spray the inside surface of the alidade lens and the cathode-ray tube face with the antistatic wax supplied with this equipment. Allow the wax to dry and polish lightly with a dry, clean cloth. This will eliminate the static accumulation which causes errors in the readings.

138. Repair of Radio Transmitter T–339/UR
(figs. 79 through 81)

a. The components of the target transmitter are accessible for easy replacement. When replacing transformers, tag the leads so that they may be replaced correctly when the new part is soldered in. Whenever replacement of any part or parts requires the disconnection of numerous leads, tag the leads so that the new connections can be made correctly.

b. Always use the proper tube puller when replacing tubes.

c. Remove the RF shields when replacing transformers.

139. Repair of Junction Box J–95B/CRD–2
(fig. 84)

The components of the junction box are accessible for easy replacement. Whenever the replacement of any part or parts requires the disconnection of numerous leads, tag the leads so that new connections can be made properly.

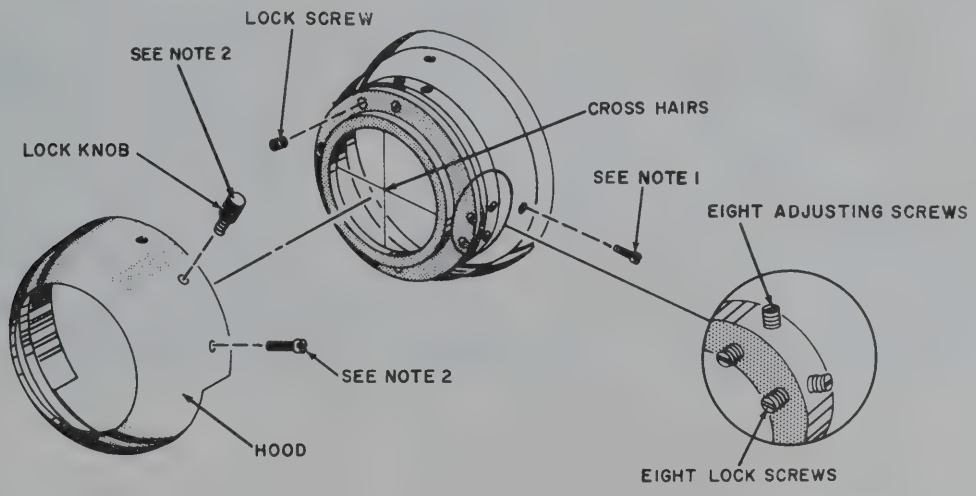


Figure 71. Adjustment of alidade.

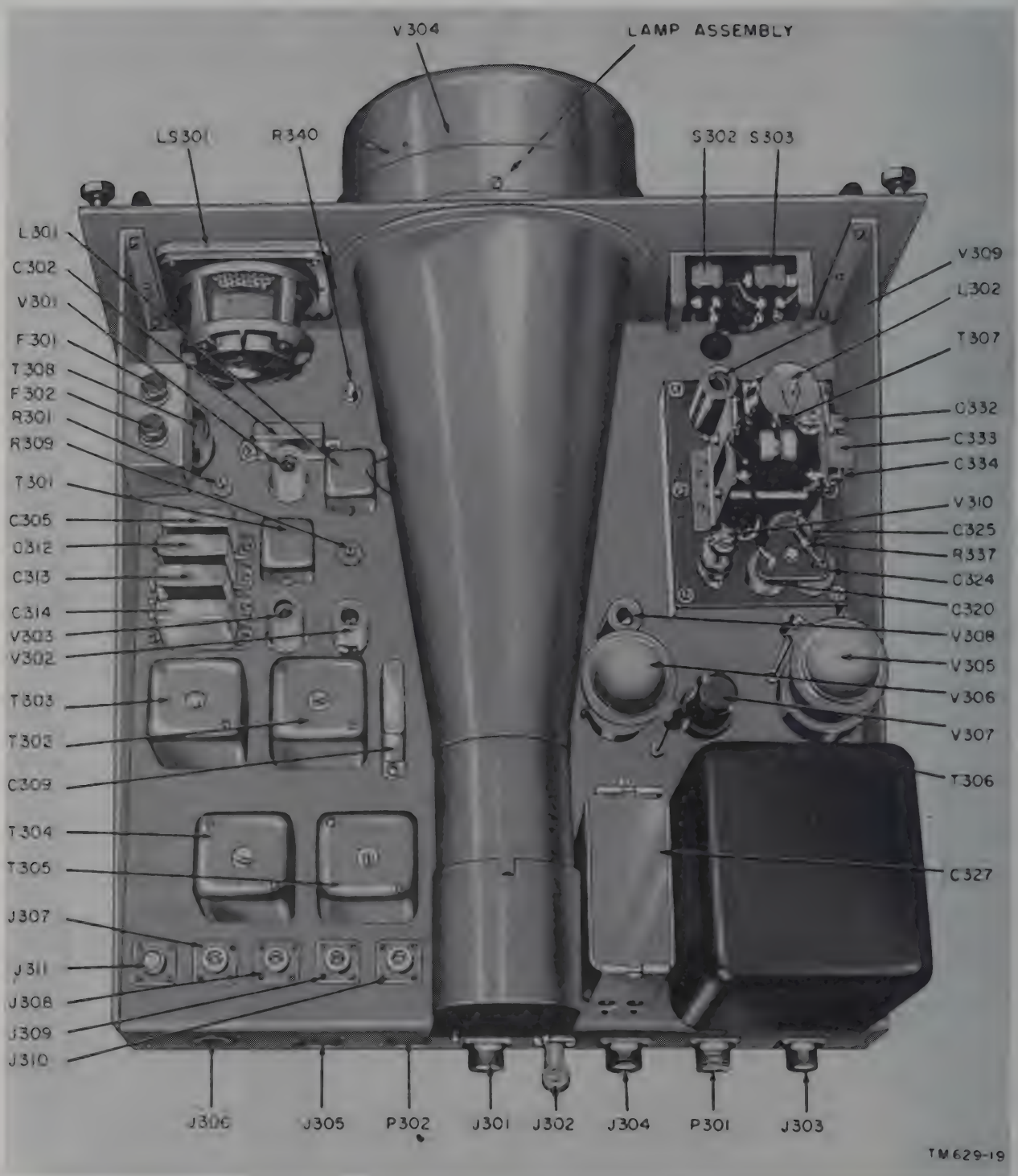


Figure 72. Azimuth Indicator IP–137/GRD, top interior view.

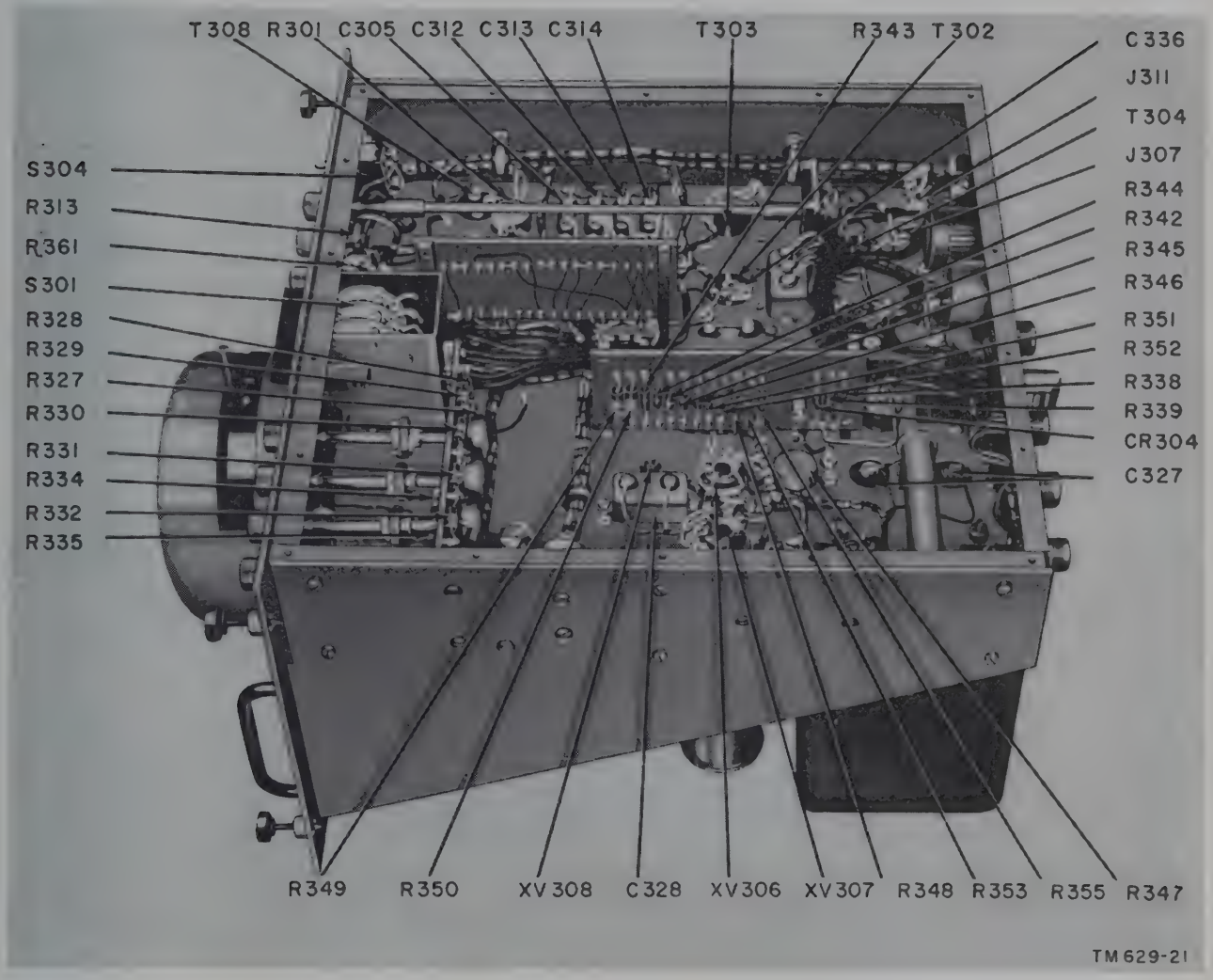


Figure 73. Azimuth Indicator IP–137/GRD, bottom view, right side.

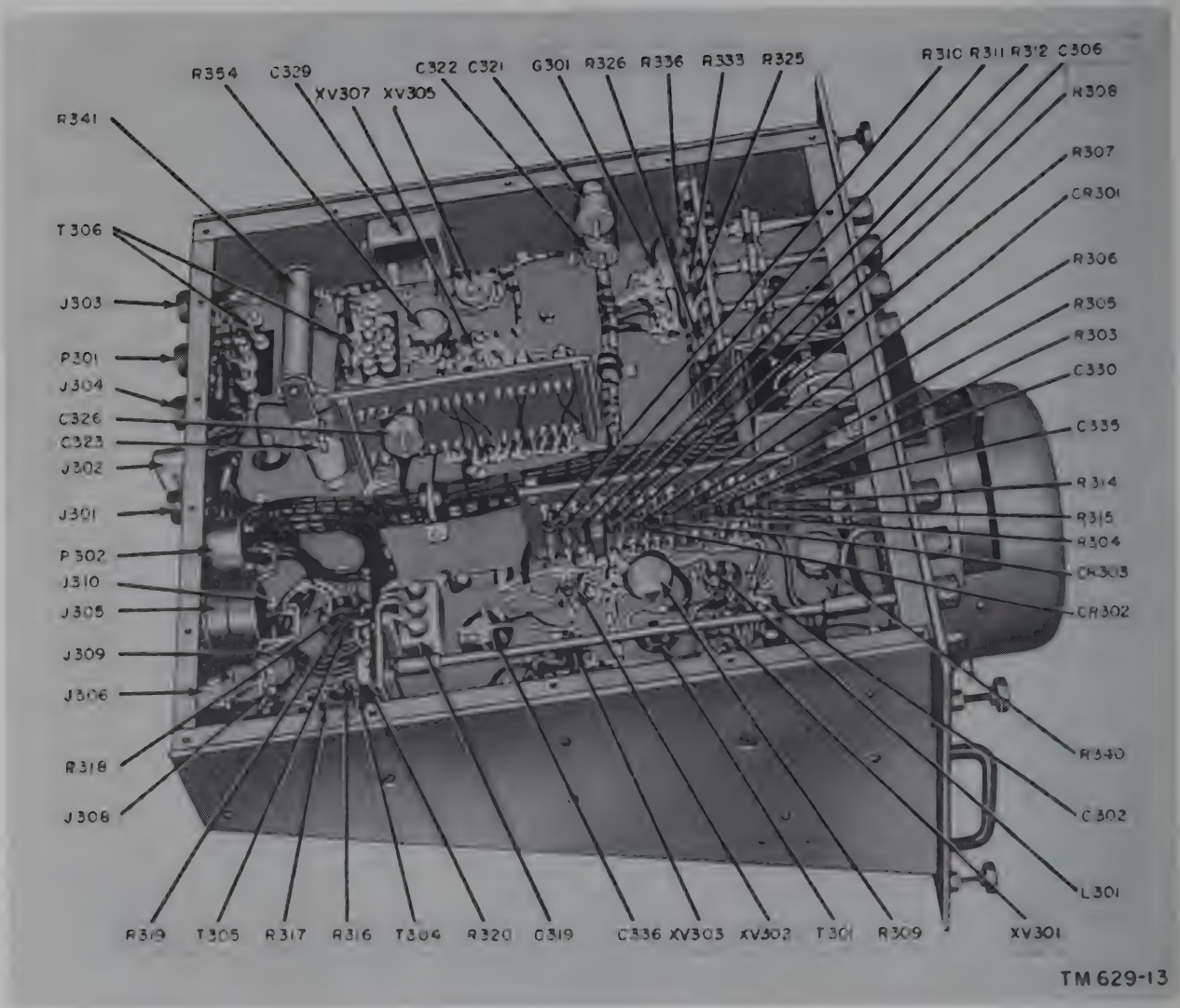


Figure 74. Azimuth Indicator IP–137/GRD, bottom view, left side.

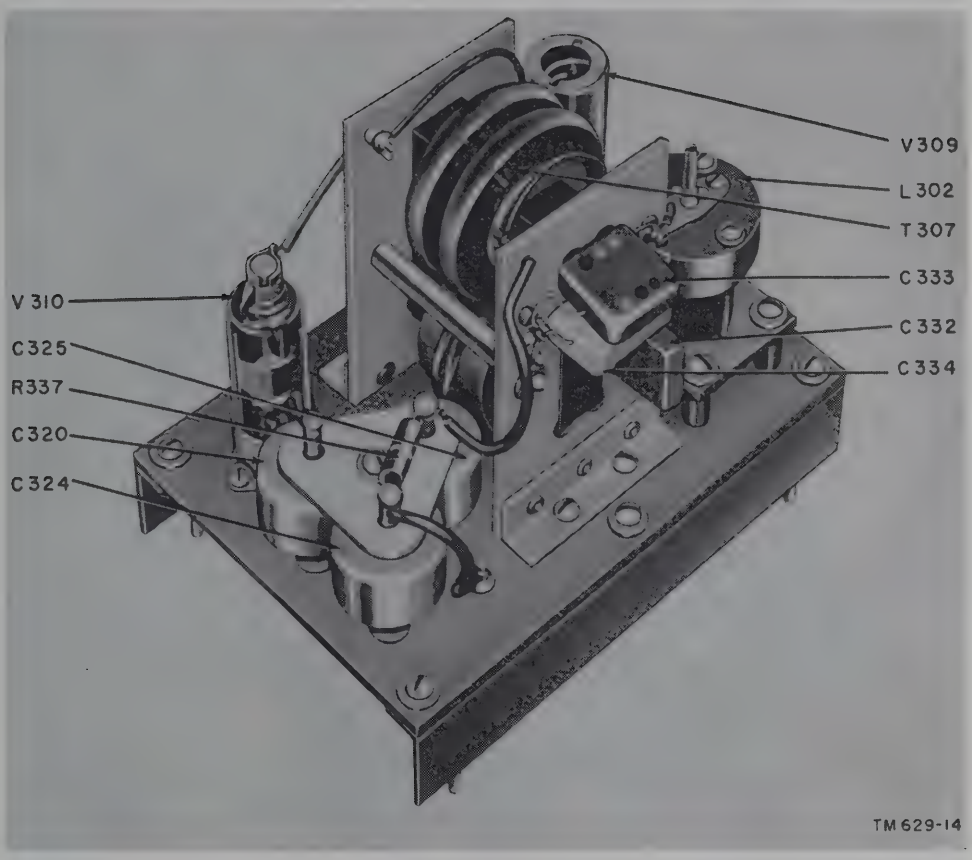


Figure 75. Power Supply PP–988/GRD, top view.

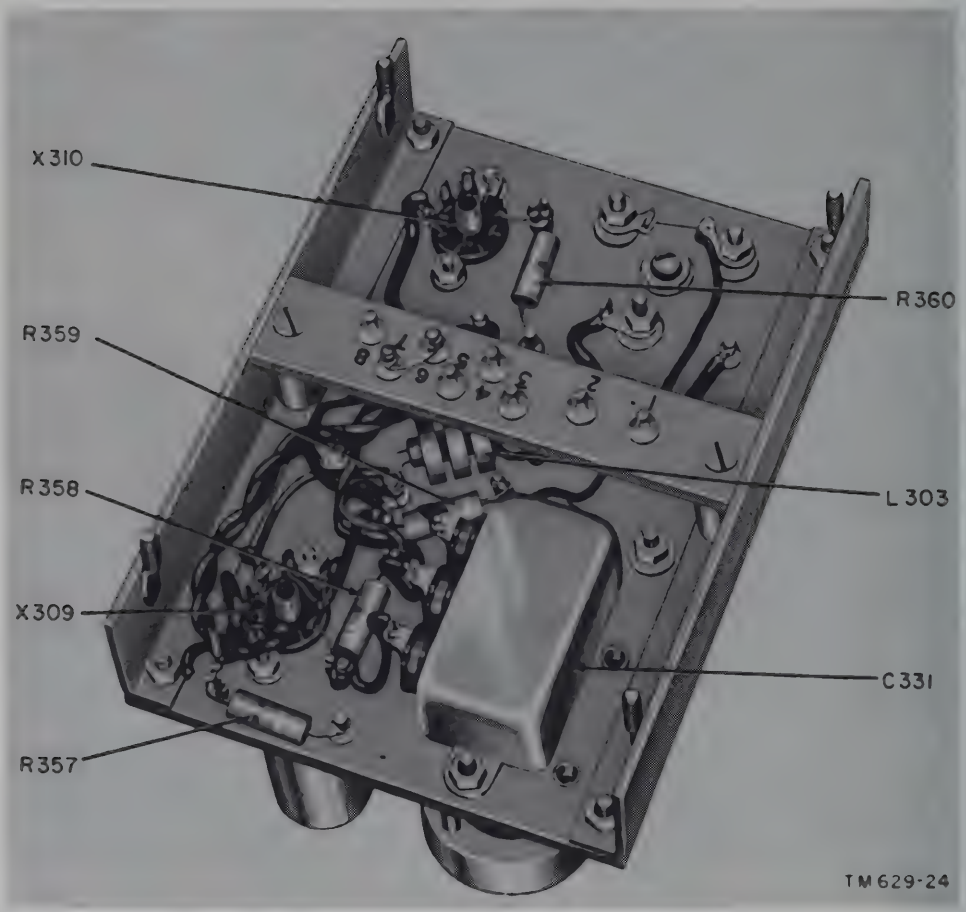


Figure 76. Power Supply PP–988/GRD, bottom view.

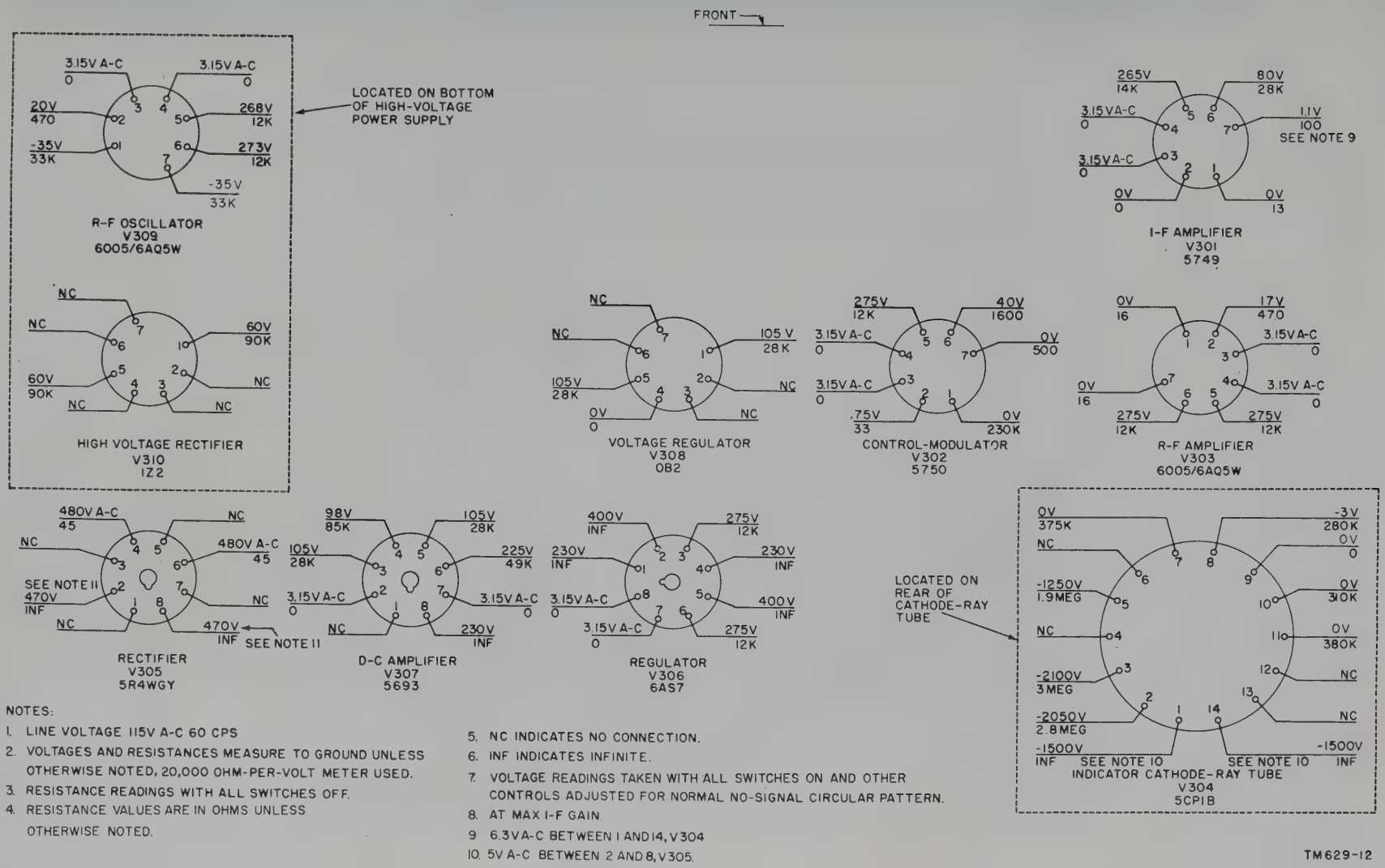


Figure 77. Azimuth Indicator IP–137/GRD, tube socket, voltage and resistance diagram.

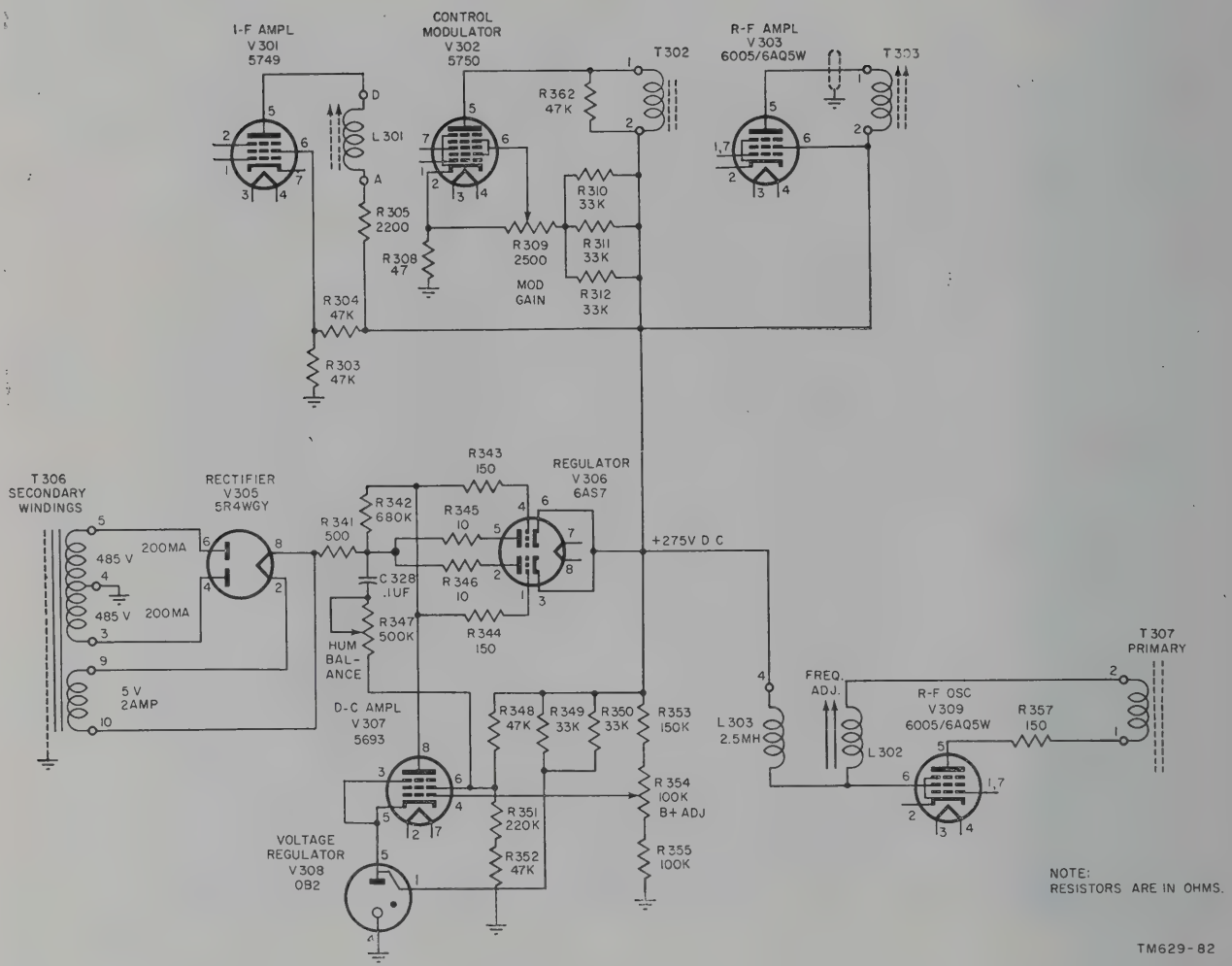


Figure 78. Azimuth Indicator IP–137/GRD, B+ voltage distribution, schematic diagram.

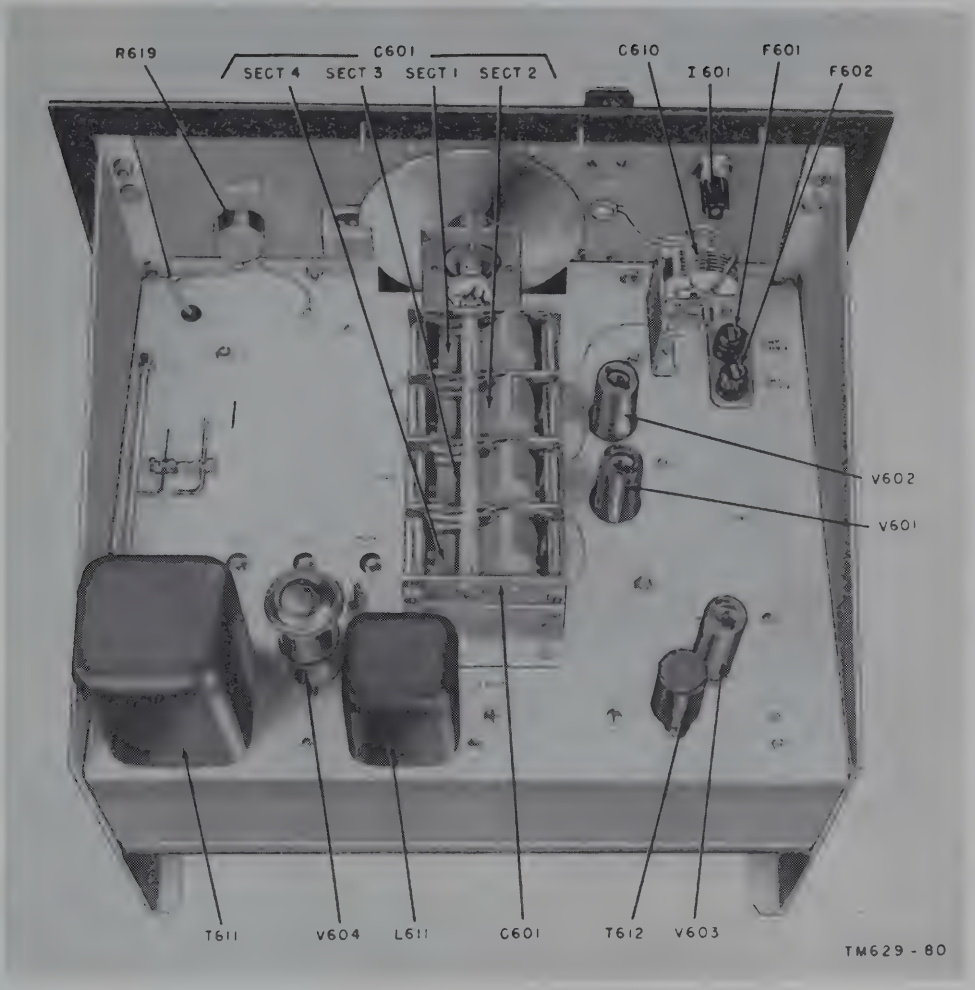


Figure 79. Radio Transmitter T–339/UR, top interior view.

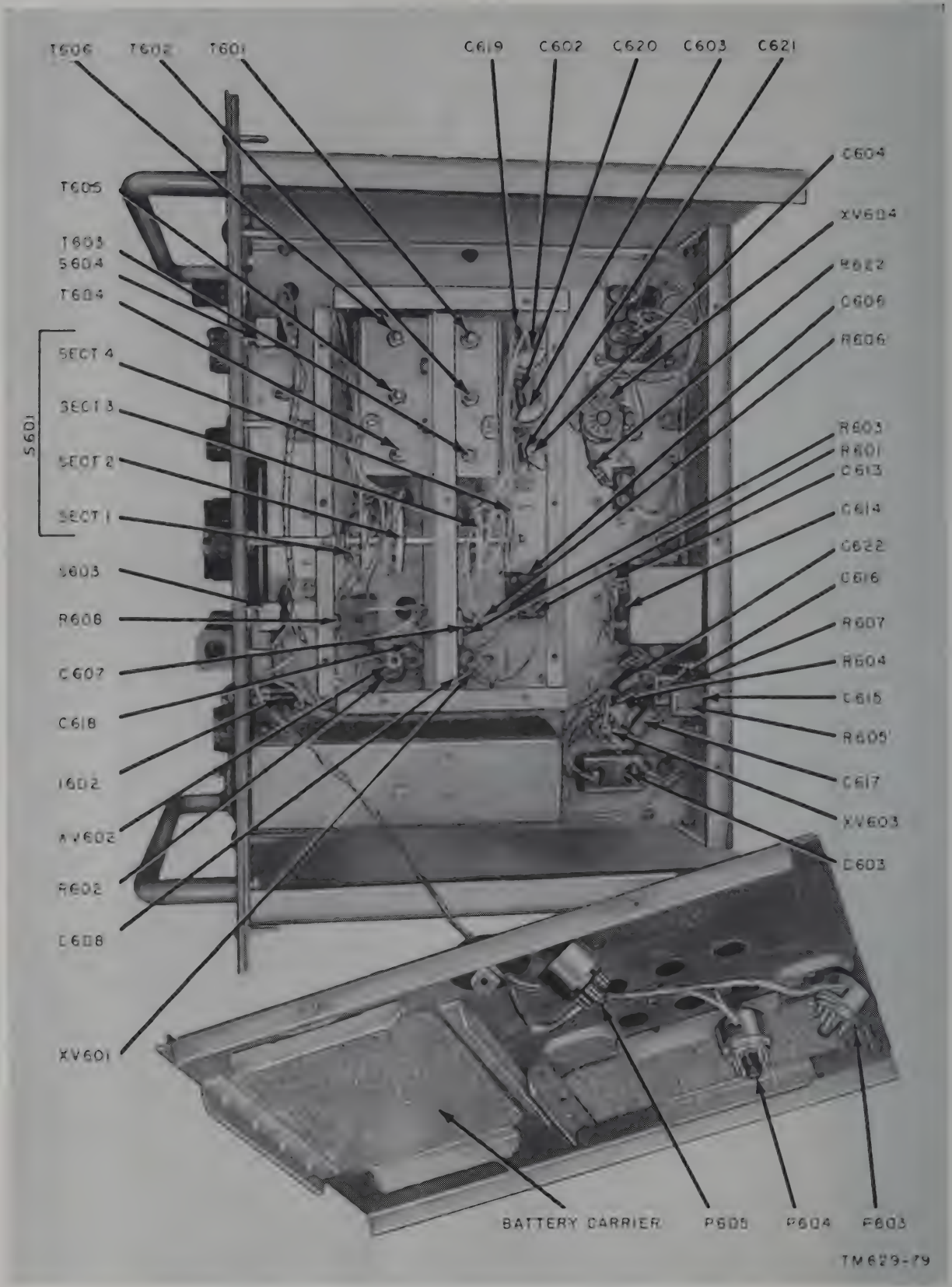


Figure 80. Radio Transmitter T–339/UR, bottom view of chassis.

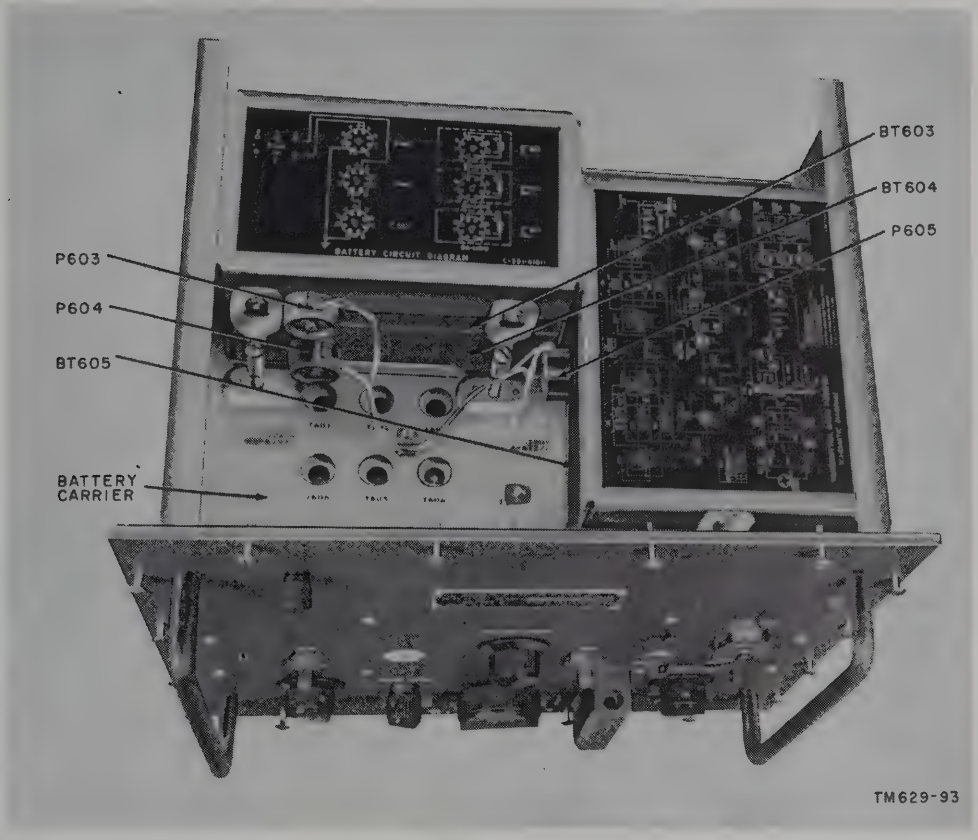


Figure 81. Radio Transmitter T–339/UR, replacing batteries.

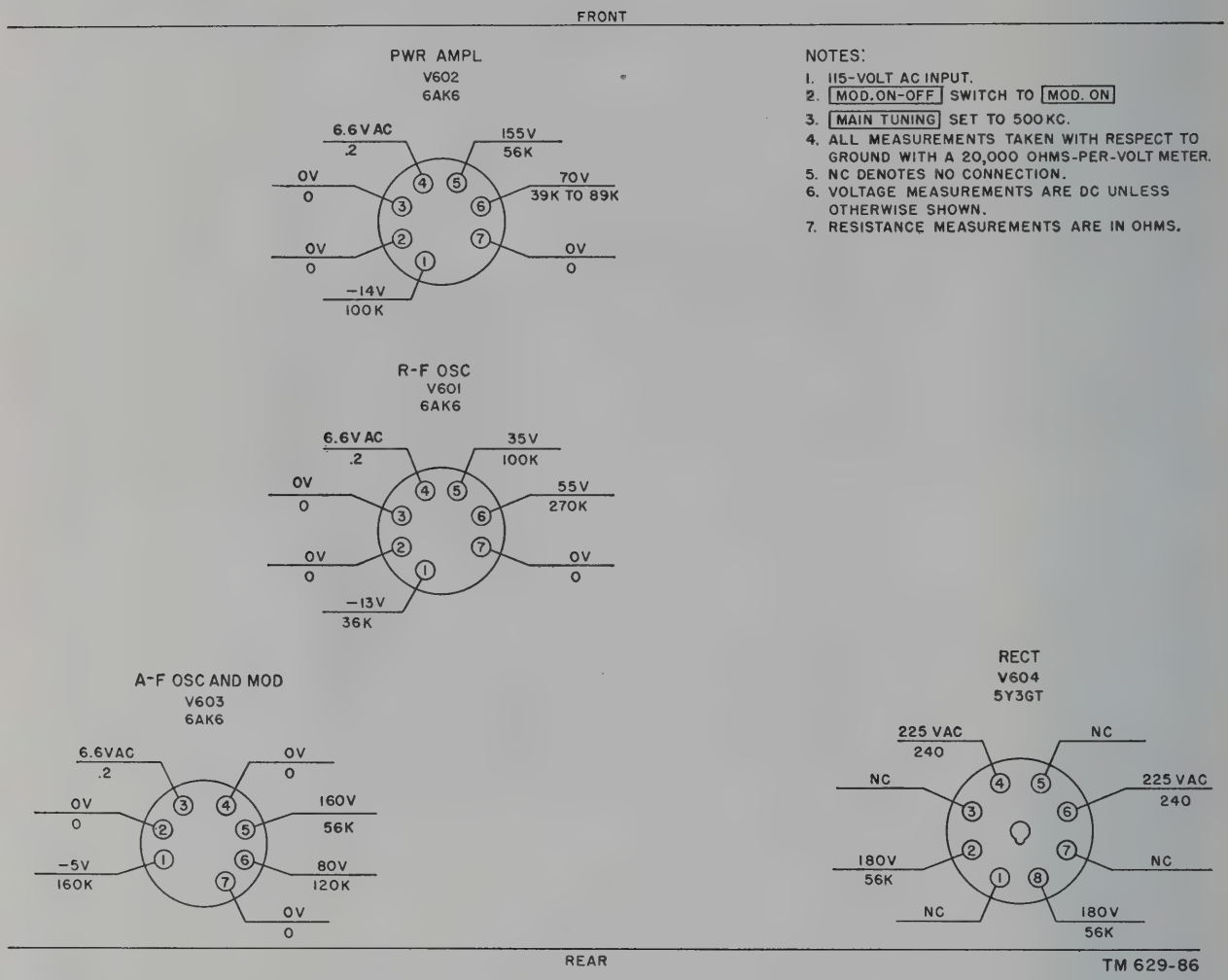


Figure 82. Radio Transmitter T–339/UR, tube socket, voltage and resistance diagram.

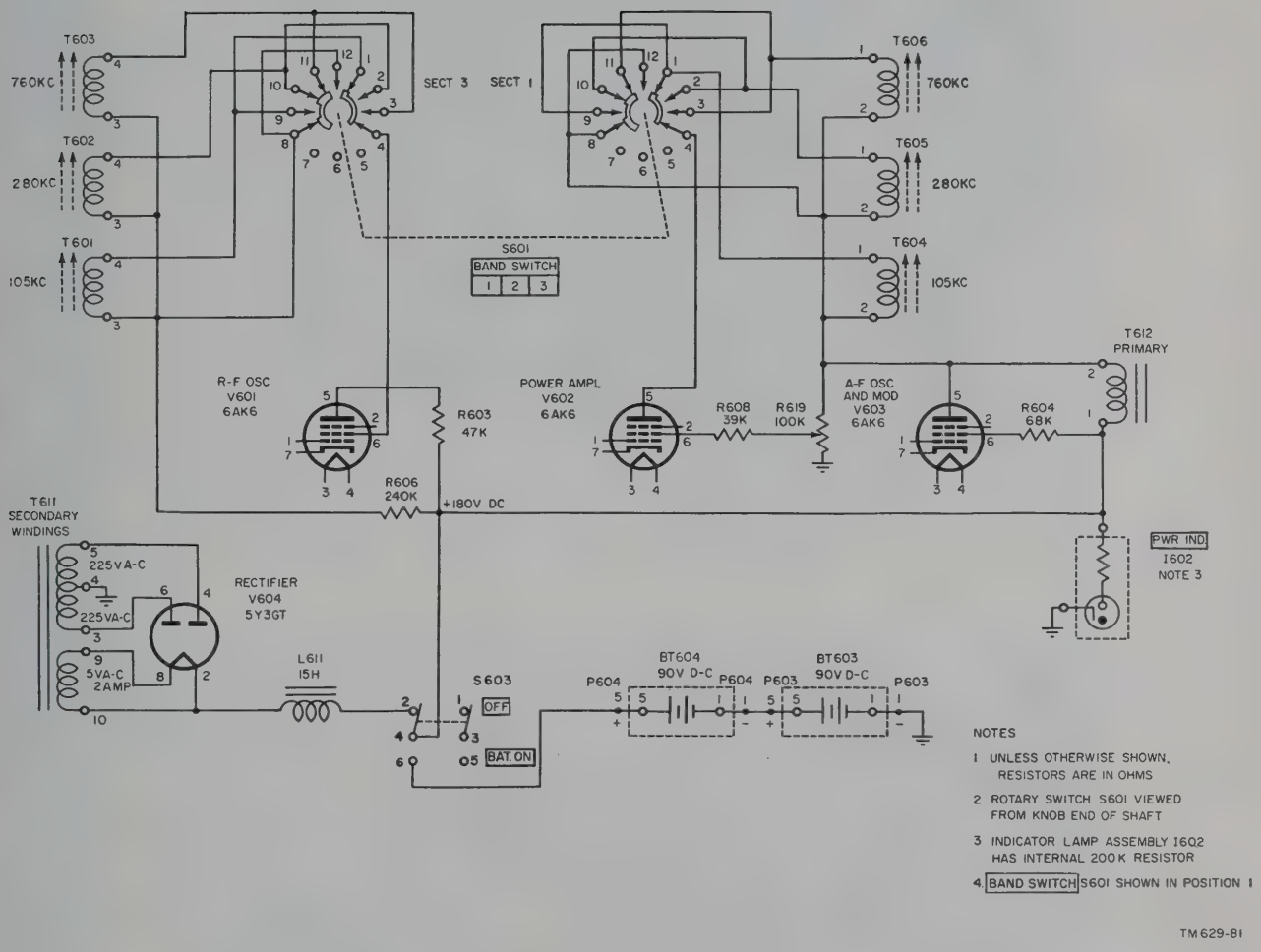


Figure 83. Radio Transmitter T–339/UR, B+ voltage distribution diagram.

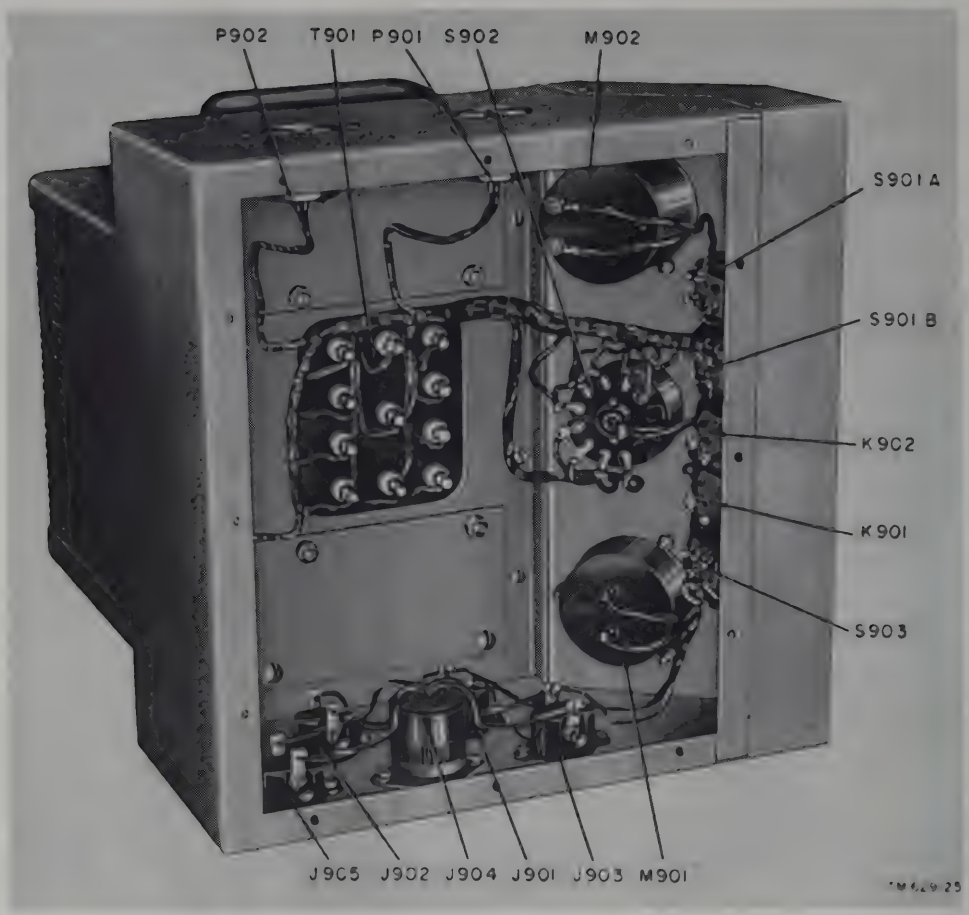


Figure 84. Junction Box J–95B/CRD–2, bottom view of chassis.

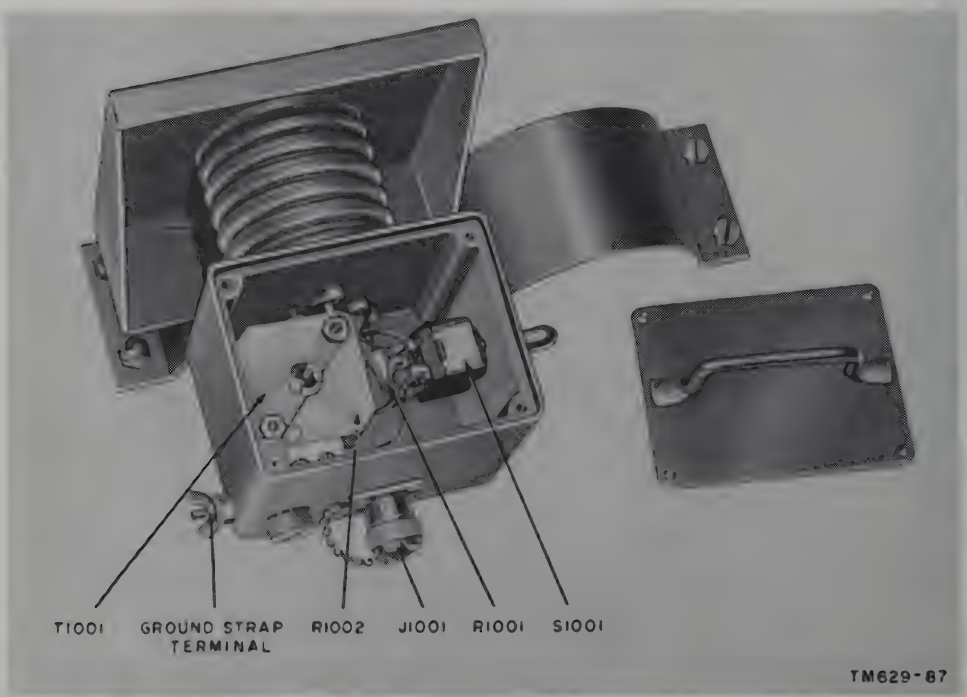


Figure 85. Antenna coupler, front view.

140. Alinement of the Signal and Indicator Goniometers and Goniometer Drive

The electrical goniometers and the goniometer drive are alined by mating the spring-loaded plunger on the coupling with the slot in the drive disk. Preoperational adjustment of the goniometers and goniometer drive to shift the indicator pattern is discussed in detail in paragraphs 42 and 44.

141. Signal Goniometer Balance Procedure

An unbalanced goniometer may give several indications, such as, pull-in, or bearing blur, reciprocal nulls not 180° apart, or inaccurate bearings. To balance the signal goniometer, proceed as follows:

a. Assembly all components of the direction finder set except the Adcock antennas. Connect the components into an operating system in accordance with figure 31.

b. Remove the two signal goniometer side plates (fig. 70).

c. Connect the vtvm to the VIDEO OUTPUT jack J301 on the azimuth indicator. Set the vtvm to read approximately 2 volts.

d. Connect the hot lead of the signal goniometer through a 300-$\mu\mu$f capacitor to the input of the north antenna coupler. Connect the ground lead of the signal generator to the screw on the side of the antenna coupler case. Connect the inputs of the east and west antenna couplers and terminate them by connecting a 300-$\mu\mu$f capacitor from their junction to ground.

e. Set the signal generator and receiver to 500 kc. Increase the signal generator output voltage to produce a slight deflection on the vtvm. Rotate the signal goniometer for a maximum reading on the vtvm.

f. Connect the input of the south antenna coupler to the junction of the north antenna coupler and the 300-$\mu\mu$f capacitor. Increase the signal generator output voltage to produce a reading on the vtvm. With a perfectly balanced goniometer, the vtvm will read 0 volt. Position the stator with the stator positioning screws (fig. 70) to reduce the vtvm reading to minimum.

g. Repeat the procedure in *c* above, with the signal generator connected to the east and then the east and west antenna couplers, and with the north and south antenna couplers connected and terminated.

h. There is considerable interaction between the two adjustments. Therefore, it is necessary to repeat the procedures in *c* through *f* above until the north-south and east-west stator windings are balanced.

i. Secure the stator positioning screws with cement and replace the side plates.

142. Indicator Goniometer Balance Procedure

To balance the indicator goniometer, proceed as follows:

a. Set the signal generator to produce a 72-kc signal output with an amplitude of 2 or 3 volts minimum.

b. Short jacks J401 and J402 and connect the signal generator to the junction. Connect the vtvm across the terminals of jack J405. Remove the goniometer side plates (fig. 90).

c. Set the vtvm to read ac volts. Set the signal generator for maximum output at 72 kc.

d. Adjust the rotor position to produce a maximum reading on the vtvm. Adjust the stator positioning screws for minimum reading on the vtvm.

e. Repeat the above procedure with the signal generator connected to jacks J403 and J404. There is considerable interaction between the two adjustments. Therefore, it is necessary to repeat the procedures in *a* through *e* above until the stator is balanced for both adjustments.

f. Secure the stator positioning screws with cement and replace the side plates.

143. Alinement of Azimuth Indicator

The azimuth indicator is alined at the factory and normally will not require readjustment. If faulty operation of the azimuth indicator is caused by improper alinement, the alinement procedures in paragraphs 144 and 145 should be used.

Caution: High voltages are exposed when the shields are removed from the azimuth indicator.

144. Bench Adjustments of Azimuth Indicator

Remove the azimuth indicator from its rack by following the directions given in paragraph 136*a*. Remove the bottom shield by removing the retaining screws. Connect a 115-volt 60-cycle power

source to connector P302 on the rear of the chassis. Turn on the azimuth indicator in accordance with the instructions in paragraph 53. Be sure to reduce the beam intensity to a minimum to avoid burning the cathode-ray tube screen.

a. 275-Volt B+ Adjustment. Set the multimeter to a voltage range for measuring 300 volts dc. Connect the negative lead of the multimeter to chassis ground. With an insulated probe, measure the voltage at the ungrounded side of capacitor C313 (fig. 72). Adjust R354 (fig. 74) until the multimeter indicates +275 volts dc.

b. Modulator Gain. With the 50-volt dc range of the multimeter, measure the voltage at the arm of potentiometer R309 (fig. 74). Adjust the potentiometer for a reading of 40 volts dc.

c. Hum Balance. Connect the vertical amplifier input terminals of the test oscilloscope between the arm of potentiometer R309 and ground. Set the internal sweep of the test oscilloscope to display 120-cycle hum. Adjust resistor R347 (hum balance) (fig. 73) for minimum hum amplitude, which is indicated by minimum vertical height of the wave form on the oscilloscope. Use maximum vertical amplifier gain to insure obtaining best hum balance adjustment.

d. 72-Kc Frequency Adjust. Set frequency adjustment (L302 accessible through hole in high-voltage supply shield) at the midpoint of its range. Loosely couple a short antenna lead from the receiver to the high-voltage oscillator by injecting a short piece of the lead (about ½ inch) through the hole in the shield. Do not allow the lead to touch the parts inside. Check the frequency of the oscillator by tuning the signal on the receiver. Be sure that the receiver is properly calibrated. Adjust L302 for a frequency of 70 to 73 kc.

145. Adjustment of Azimuth Indicator Mounting in Rack

Adjust the INTENSITY, FOCUS, DIMMER, HORIZONTAL, and VERTICAL centering controls in accordance with instructions in paragraph 53. Set the receiver FUNCTION switch to the standby position and turn on the goniometer drive to produce a circular pattern on the azimuth indicator.

a. Size Control Adjustment. Advance the SIZE control until the pattern diameter is approximately 3 inches.

b. T302 Adjustment. Adjust C307 (tuning adjustment at top of T302) to the middle of its range. Set C336 (below chassis and accessible with indicator pulled forward) for maximum pattern diameter.

c. T303 Adjustment. Adjust the slug at top of T303 for maximum pattern diameter. After ½-hour operation, readjust the slug to compensate for slight oscillator drift.

d. T305 Adjustment. Adjust C317 at the top of T305 (horizontal deflection transformer) for maximum pattern diameter in horizontal plane. Adjust the SIZE control for a 4-inch pattern diameter in the horizontal plane.

e. Shape Adjustment. Adjust the SHAPE control to approximately one-half of its full clockwise position. Set the slug at the base of T304 (accessible through vent hole in bottom shield) for slightly less than a 4-inch circular pattern. Adjust C315 at the top of T304 (vertical deflection transformer) for maximum vertical amplitude. Readjust the SHAPE control and C315 until a 4-inch circular pattern is obtained. A 4-inch circle should be obtained at approximately half-range of the SIZE control.

f. Cathode-Ray Tube Adjustment. Remove F301 to disable the driver motor. Remove the cables from J309 and J310 and rotate the goniometer drive azimuth scale for maximum vertical line length. Recheck the centering as previously outlined. Note the degree of the tube rotation necessary to orient the trace to 0° and 180°. Remove the alidade (par. 137) and lubricate the grommets that support the tube with soapy water. Remove the cathode-ray tube base shield at the rear of the unit and rotate the tube slightly to aline the trace to 0° and 180°. Replace the alidade and set the forward position to the tube face as close to the alidade as possible without interfering with the operation of the rotatable cross hairs (par. 137).

g. Cathode-Ray Tube Deflection Plate Check. Move the leads now connected to J307 and J308 to J309 and J310. The line will rotate 90°. The resulting horizontal line should be within ½° of 90° and 270°. If the line is more than ½°, replace the cathode-ray tube.

h. Azimuth Scale Check. Reinsert F301 to energize the goniometer drive and connect all cables properly. Carefully set up the normal no-signal pattern as outlined at the beginning of this paragraph. Again remove F301 and rotate the goniometer drive azimuth scale manually, setting the

line pattern on 0° to 180°. Adjust the goniometer index to 0° on the azimuth scale. Check the accuracy of the azimuth indicator every 10° by comparing the aural scale with the visual scale readings. Record the data for future reference. Reinsert F301.

i. Alinement of 455-Kc Circuits. Connect the signal generator to J302 and set the frequency to 455 kc. With a signal generator output of approximately 10 millivolts, adjust T301, R301, and L301 for minimum circle diameter. Adjust the output amplitude of the signal generator until the circle is dot size. The reading of the signal generator should be less than 25 millivolts.

j. Transformer T301 Readjustment. Place the receiver FUNCTION switch in the MGC position. Tune in a strong signal and adjust the receiver RF GAIN control so that the smallest dimension of the propeller is approximately ½ inch in diameter. Readjust the slug of T301 for minimum pattern diameter.

k. IF Gain Adjustment. Adjust the vacuum-tube voltmeter to a range in excess of 5 volts dc and connect between pin A of connector J301 and ground. Advance the RF GAIN to maximum. Tune the receiver throughout the operating range (100 to 1,500 kc). Note the frequencies of minimum noise output as indicated by a minimum reading on the vacuum-tube voltmeter. At one of the points of minimum noise adjust IF gain control R301 on the top of the indicator chassis to produce a .7-volt reading on the meter.

l. Sense Phase Adjustment. Retune the receiver to a signal and press the SENSE switch. Adjust R340 (sense phasing) to eliminate the ghost sense pattern.

146. Alinement of Target Transmitter

An alinement tool and the frequency meter are required for the alinement of the target transmitter. Refer to figures 79 and 80 for alinement points.

a. Preliminary Adjustments.

(1) Remove the dust cover from the target transmitter.

(2) Remove the cover from the RF transformer assemblies and adjust all trimmer capacitors to the approximate midpoint of the mechanical adjustment range. Replace the cover.

(3) Assemble the five-section whip antenna and secure it in the mounting receptacle on the front panel.

(4) Connect to a source of 115-volt, 60-cycle ac power. Set the BAT. switch to OFF.

b. Alinement of Band 1.

(1) Set the BAND SWITCH to position 1.

(2) Set the MOD. switch to OFF.

(3) Turn the MAIN TUNING knob until the dial is set at the alinement frequency of 105 kc.

(4) Turn A. C. switch to ON. Allow a 5-minute warmup period. Adjust the frequency meter to 105 kc. Loosely couple the frequency meter antenna output to the target transmitter antenna with a short length of wire.

(5) Adjust the ANT. TUNING control to maximum output as indicated by the TUNING IND.

(6) Set the OUTPUT control to midposition.

(7) The output signal from the target transmitter should be heard in the frequency meter headset. Readjust OUTPUT control for a comfortable signal level. Using the alinement tool, adjust the slug in T601 until zero beat is obtained in the frequency meter output.

(8) Tune the slug in T604 for maximum output as indicated by the TUNING IND. lamp.

(9) Repeat the procedures in (7) and (8) above as necessary to obtain proper adjustment. It is possible that adjustment of T604 will affect the setting of T601. Repetition of the procedure in (7) above will indicate if zero beat still exists for 105 kc.

(10) Turn the MAIN TUNING knob until the dial is set at the upper alinement frequency of 255 kc. Set the frequency meter to 255 kc.

(11) Adjust the ANT. TUNING control for maximum output as indicated by the TUNING IND.

(12) Adjust trimmer capacitor C602 for a zero beat in the frequency meter (frequency meter set to 255 kc).

(13) Repeat the procedures in (11) and (12) above as required to achieve proper adjustment.

(14) Retune the transmitter and frequency meter to 105 kc and repeat the procedures

in (5), (7), and (8) above as required to correct the alignment to 105 kc. If any adjustments are repeated for the 105-kc alinement, then it will be necessary to recheck and repeat the procedures in (10), (11), and (12) above.

c. Alinement of Band 2. Alinement procedure for band 2 is identical with that of band 1, with the following exceptions.

(1) The BAND SWITCH is set at position 2.

(2) The alinement frequency for the low end of band 2 is 280 kc (T602 and T605); for the high end of band 2, the frequency is 700 kc (C603).

d. Alinement of Band 3. Alinement procedure for band 3 is identical with that of bands 1 and 2, with the following exceptions.

(1) The BAND SWITCH is set at position 3.

(2) The alinement frequency for the low end of band 3 is 760 kc (T603 and T606); for the high end of band 3, the frequency is 1,900 kc (C604).

e. Checking for Correct Alinement. After completing the alinement procedures for all three bands, replace the dust cover. With a calibrated radio receiver or with the frequency meter used in the alinement procedure, check to see that the transmitter signal appears at the proper frequencies indicated by the dial at several points on each band. Use the final testing procedure described in paragraph 155.

147. Alinement of Antenna Coupler

The antenna coupler is alined when it is produced. The adjustment is cemented and should not be turned. Misalinement of coil T1001 will result in an unbalance in the antenna system.

Section VIII. FINAL TESTING

148. General

Each component of the direction finder set which has been repaired should be tested in accordance with the final testing procedures given in this manual or the manual of the individual equipments (par. 1). Any component passing the tests indicated is considered suitable for field use. Any failure of the equipment to meet the specifications given is an indication that additional trouble shooting or alinements is needed. Operate the assembled equipments of the direction finder set in accordance with equipment performance checklist (par. 74) to make an overall test with the antenna system.

149. Final Testing of Direction Finder Set

a. After applying final test procedures to the individual components of the radio set, the equipment should be assembled and given an overall performance test to determine if the overall performance meets certain standards. These tests will be given in addition to the checks prescribed by the equipment performance checklist (par. 74):

(1) Sensitivity test.

(2) Balance test.

(3) Bearing accuracy and sense test.

b. These tests may be performed in the repair area without the Adcock antenna system.

150. Components Used in Final Test

Assemble all components of Direction Finder Set AN/TRD–3, less Antennas AS–595/GR. Connect the components into an operating system in accordance with figures 29 and 31.

151. Preliminary Adjustments

Make the following preliminary adjustments in preparation for the final test.

a. Turn on all equipments and allow a warmup period of at least 15 minutes.

b. Adjust the receiver as follows:

(1) Set the IF BANDWIDTH switch to the 2 KC position.

(2) Set the FUNCTION switch to MGC position.

(3) Turn the BFO switch to OFF.

(4) Turn the LIMITER control fully counterclockwise.

c. Adjust the azimuth indicator as follows:

(1) Adjust the INTENSITY and FOCUS controls to provide a clear, well-defined pattern.

(2) Adjust the SHAPE control to provide a circular pattern.

(3) Reduce the pattern to a dot with the SIZE control.

(4) Center the dot by adjusting the HORIZONTAL and VERTICAL controls.

(5) Adjust the SIZE control to set the pattern size to coincide with the inner diameter of the azimuth scale.

152. Sensitivity Test

The purpose of this test is to check the sensitivity of the receiver and azimuth indicator units. To perform the sensitivity test, proceed as follows:

a. Connect the signal generator set for zero output to the input of the north antenna coupler through a dummy antenna that consists of a 300-$\mu\mu$f capacitor. Connect the ground side of the generator to the screw on the side of the antenna coupler case. Terminate the remaining antenna couplers by connecting a 300-$\mu\mu$f capacitor between the input of the antenna coupler and the screw on the side of the antenna coupler case.

b. Set the vtvm to read voltages of approximately 2 volts dc. Connect the vtvm to VIDEO OUTPUT jack J301 on the azimuth indicator.

c. Set the signal generator and receiver to 100 kc. Set the switches on all antenna couplers to the 100-300-kc position. Advance the RF GAIN control on the receiver to produce a reading of at least .4 volt on the vtvm. Without changing the receiver control settings, increase the signal generator output until the vtvm indicates a voltage three times the value obtained with no signal generator output. The signal generator output is the direction finder sensitivity.

d. Perform the sensitivity tests for the frequencies indicated in the following table. The direction finder sensitivity should not exceed the values indicated.

Test frequency (kc)	Direction finder sensitivity (microvolts)
Antenna coupler switch in 100- 300 kc position—	
110	35
150	25
200	25
300	25
350	25
Antenna coupler switch in 300- 1500-kc position—	
300	50
350	45
450	30
900	20
1500	20

e. If the equipment does not meet the sensitivity limits, reverse the position of the north-south and east-west couplers at the goniometers and repeat the test. This will indicate a defective coupler or antenna cable. If the equipment still fails the test, check the signal goniometer (par. 123), radio receiver (TM 11–855), and azimuth indicator (par. 128).

153. Balance Test

The purpose of this test is to check the balance between the north and south antenna coupling circuits and between the east and west antenna coupling circuits. To perform the balance test, proceed as follows:

a. Turn on the equipment and allow a warm-up period of at least 15 minutes.

b. Connect the signal generator to the north antenna coupler as in the sensitivity test (par. 152). Terminate the east and west antenna couplers and connect the vtvm as in the sensitivity test.

c. Set the receiver and signal generator to 100 kc. Set the switches on all antenna couplers to the 100–300 kc position. Adjust the signal generator output to 100 microvolts. Adjust the receiver RF GAIN control to produce a reading of 2 volts on the vtvm. Do not change the setting of this control for the remainder of the test.

d. Connect the inputs of the south antenna coupler and the north antenna coupler.

e. Advance the signal generator output until the vtvm again reads 2 volts. The ratio of the signal generator output to the original 100-microvolt output is the balance ratio.

f. Repeat the steps in *b* through *e* above for the frequencies listed in the following table. The balance ratio for each test should not be less than the values listed in the table.

g. After performing the tests, connect the signal generator to the east antenna coupler and terminate the north and south antenna couplers. Repeat the procedures in *b* through *f* above connecting the west antenna coupler to the east antenna coupler to measure the balance ratio.

h. If the equipment does not meet the minimum requirements, the goniometers should be replaced or repaired (pars. 123, 141, and 142).

153*b* (Continued)

Test frequency	Minimum balance ratio
Antenna coupler switch in low frequency range:	
110	150:1
150	150:1
200	150:1
250	100:1
300	90:1
350	75:1
Antenna coupler switch in high frequency range:	
300	150:1
350	150:1
500	150:1
900	75:1
1500	50:1

154. Bearing Accuracy and Sense Check

The purpose of this check is to check the instrumental accuracy of the direction finder set. The test is performed with the goniometer drive assembly adjusted at 500 kc and the bearings at other frequencies are compared to the 500-kc bearings. To perform the test, proceed as follows:

a. Connect the signal generator to the north antenna coupler as in the sensitivity test (par. 152). Place the range switch on all antenna couplers in the 300–1500 kc position. Terminate all unused couplers as in the sensitivity test.

b. Tune the signal generator and receiver to 500 kc. Adjust the signal goniometer (par. 42) to produce a visual bearing of 0°. Adjust the position of the azimuth scale index on the goniometer drive to produce a 0° aural bearing.

c. Successively, connect the signal generator to the north and east antenna couplers, the east antenna coupler, the east and south antenna couplers, the south antenna coupler, the south and west antenna couplers, the west antenna coupler, and the west and north antenna couplers. Record the visual and aural bearings for each of the above connections at each frequency and antenna couplers switch position listed in the sensitivity test (par. 152). The bearings recorded for the above connections should be 0°, 45°, 90°, 135°, 180°, 225°, 270°, and 315°. The limits for the test are as follows:

(1) The bearings should be accurate within 3°.

(2) The goniometer drive is adjusted for a 0° reading at 500 kc (*b* above). At other test frequencies, the 0° bearing may shift. This condition is called goniometer zero shift. The maximum allowable shift is 2°. Record the amount of zero shift and readjust the goniometer drive for 0° bearing at each test frequency.

(3) The two propeller tips or aural bearings should be exactly 180° apart. Record any error in the reciprocal bearings. The maximum allowable deviation is 2°.

155. Final Testing Target Transmitter

a. Final tests of the target transmitter will indicate that sufficient RF output is available over the frequency range of the transmitter. A vtvm, with RF probes is the test equipment required for output tests.

b. Assemble the antenna and clip the RF probe to the antenna near the base. Connect the probe ground to the transmitter chassis or case (avoid clipping the ground to painted surfaces).

c. Turn on the target transmitter. Set the MOD. switch to ON. Turn the OUTPUT control fully clockwise.

d. The minimum output as indicated by the vtvm should be 80 volts at the following frequencies: 100 kc, 250 kc, 500 kc, 1,000 kc, 1,500 kc, and 2,000 kc.

CHAPTER 7

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

156. Disassembly

The following instructions are to be used as a guide for preparing Direction Finder Set AN/TRD–3 for transportation and storage.

a. Disconnect all outside power cords and RF transmission lines to the Adcock antenna.

b. Dismantle the Adcock antenna masts, following a reverse procedure to that described in paragraph 31.

c. Pull up the stakes that hold the mast bases. Fold the counterpoise of each antenna mast (par. 28*b*). Pull the center anchor rod, and remove all the mast-raising anchor rods.

d. Pull the RF transmission lines on the reel assembly. Clean the RF cables as they are reeled in, by allowing the cable to pass through a cloth held around the cable. Roll the first two cables against the outside of the roller and the second two toward the center.

e. Roll up the power cable and stow it in the trailer of the power unit.

f. Disconnect the power cords from the junction box and terminal box.

g. Remove the racks from the table.

h. Disassemble the table and fold the chairs.

i. Remove the terminal box from its wall mounting position.

j. Disassemble the shelter according to the instructions in TM 11–2599.

157. Repackaging for Shipment or Limited Storage

The exact procedure for repackaging depends on the material available and the conditions under which the equipment is to be shipped or stored. Adapt the procedures outlined below whenever possible. The information concerning the original packaging will also be helpful. Refer to the technical manuals (par. 1*b*) for repackaging the receiver, the power unit, and the shelter. Check for completeness of the direction finder set against the table of components (par. 5).

a. Material Requirements. The following materials are required for packaging the direction finder set. For stock numbers of materials, consult SB 38–100, Preservation, Packaging and Packing Materials, Supplies, and Equipment Used by the Army.

Material	Quantity
Waterproof paper	450 sq ft
Waterproof tape (2″ width)	107 ft
Steel strapping (⅝″ x .020)	251 ft

b. Packaging. The items of the direction finder set are to be packaged as outlined below.

(1) *Technical literature.* Package each manual by inclosing it within a close-fitting bag fabricated of waterproof paper. Seal seams with waterproof tape.

(2) *Antenna equipment.* Place and secure the antenna equipment within the assigned bag. Close the bag and secure all fastenings. Wrap each bag in waterproof paper and seal all seams with waterproof tape.

(3) *Components.* Place and secure the components within the assigned cases (par. 20). Close the cases and secure the fastenings.

c. Packing. Place each packaged bag within a nailed wooden box. Use paragraph 20 as a guide. Boxes 1 through 5 are for the packaged bags. Place the cases in wooden boxes 6 through 17 (app II). Use metal strapping around boxes intended for intertheater shipment.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

158. General

The demolition procedure outlined in paragraph 159 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

159. Methods of Destruction

a. Smash. Smash the tubes, cords, and capacitors; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut cords and wiring; use axes, handaxes, and machetes.

c. Burn. Burn cords, resistors, capacitors, coils, wiring, and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

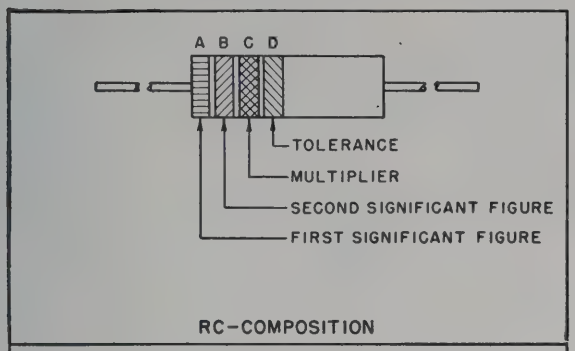
d. Bend. Bend panels and chassis.

e. Explosives. If explosives are necessary, use firearms, grenades, or TNT.

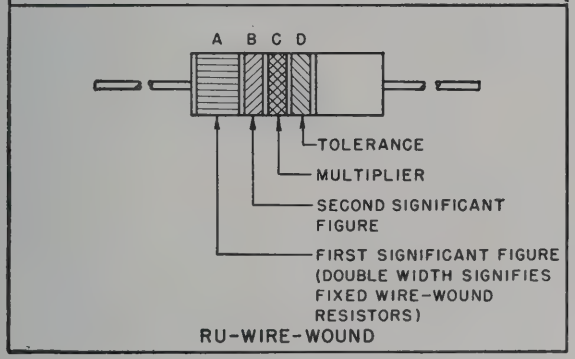
f. Disposal. Bury or scatter the destroyed parts in slit trenches, fox holes, or other holes, or throw them into the streams.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

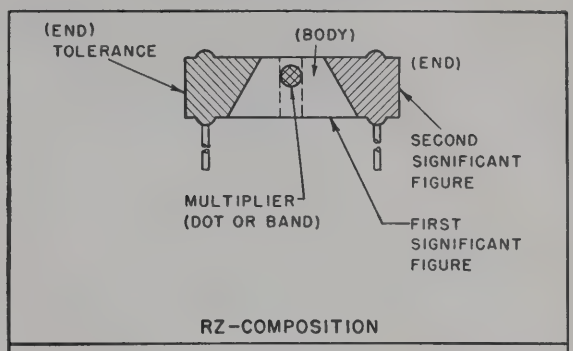


RC-COMPOSITION

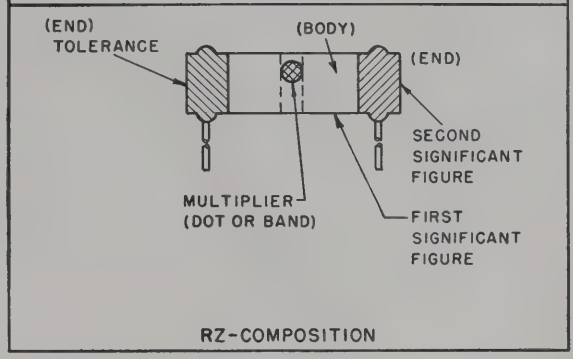


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR, THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

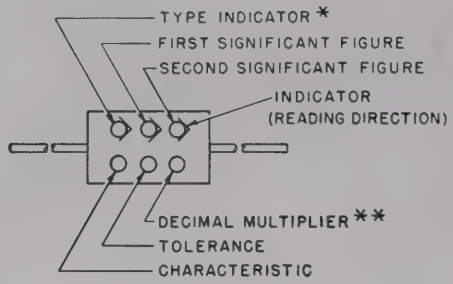
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-RI

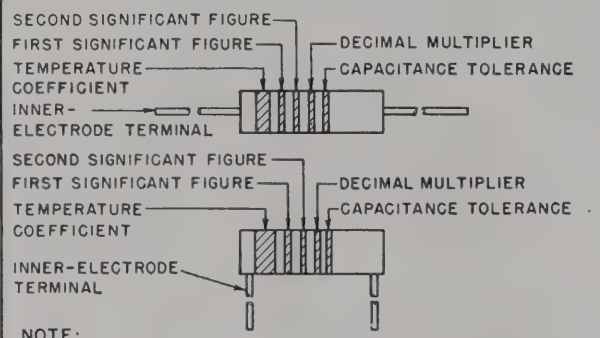
Figure 86. MIL–STD resistor color code.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



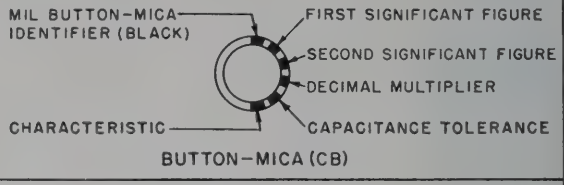
* BLACK DOT: MICA DIELECTRIC
SILVER DOT: PAPER DIELECTRIC
** INDICATES NUMBER OF ZEROS ON PAPER TYPE.

MICA (CM) AND PAPER (CN)

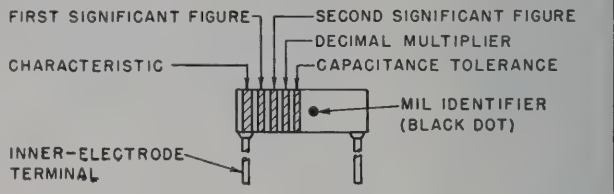


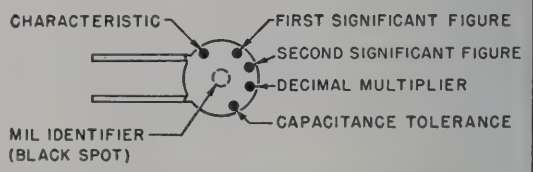
NOTE:
SPOTS MAY BE USED INSTEAD OF BANDS; TEMPERATURE COEFFICIENT MARKING IS LARGER.

CERAMIC-TEMPERATURE COMPENSATING (CC)



BUTTON-MICA (CB)





NOTES:
1. SPOTS MAY BE USED ON TUBULAR CAPACITORS; CHARACTERISTIC SPOT IS LARGER AND MIL IDENTIFIER IS ON SIDE DIAMETRICALLY OPPOSITE COLOR SPOTS.
2. MIL IDENTIFIER OF DISK TYPE IS ON REVERSE SIDE; CHARACTERISTIC SPOT IS LARGER OR SPACE BETWEEN CHARACTERISTIC AND TOLERANCE SPOTS IS THREE TIMES SPACE BETWEEN ADJACENT SPOTS.
3. TOLERANCE: YELLOW, +100%, -20%.

CERAMIC-GENERAL PURPOSE (CK)

CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE [2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500) [3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 87. MIL-STD capacitor color code.

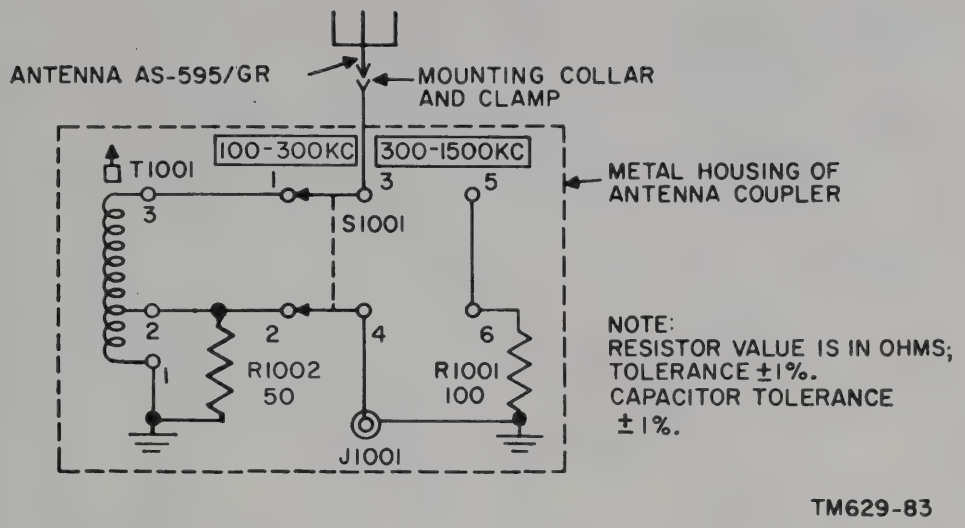


Figure 88. Antenna coupler, schematic diagram.

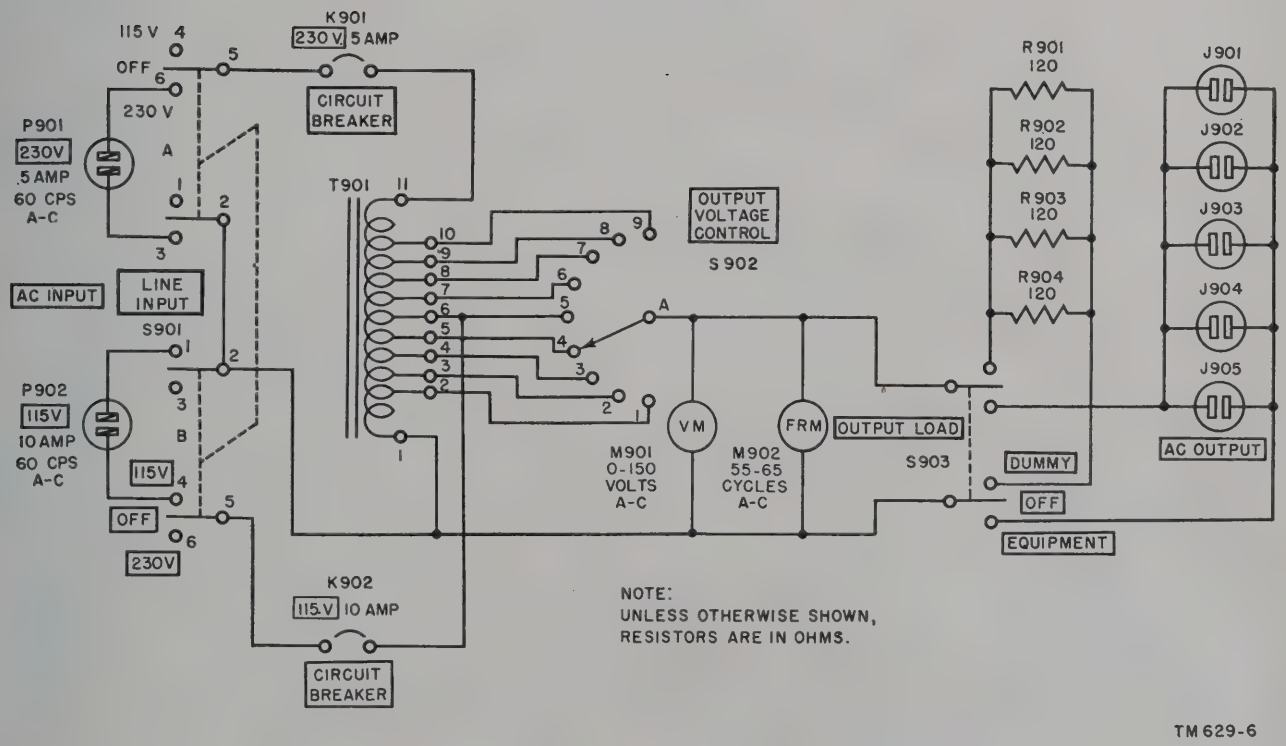


Figure 89. Junction Box J–95B/CRD–2, schematic diagram.

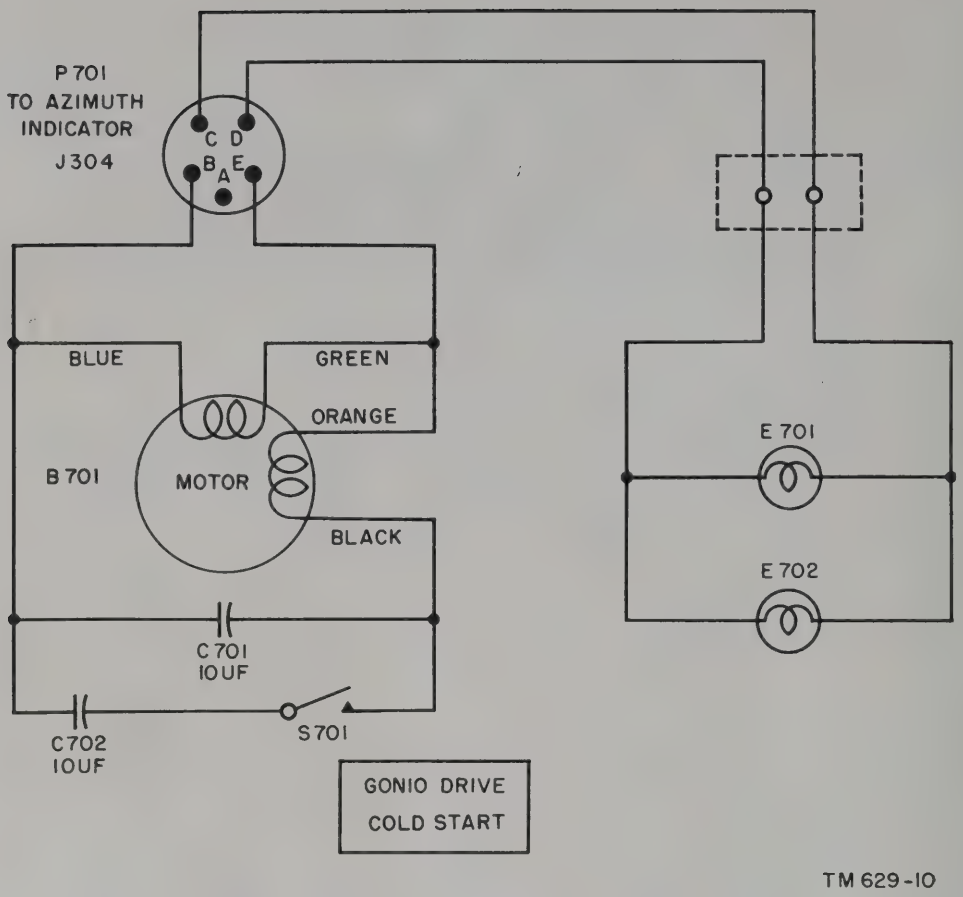


Figure 90. Goniometer drive, schematic diagram.

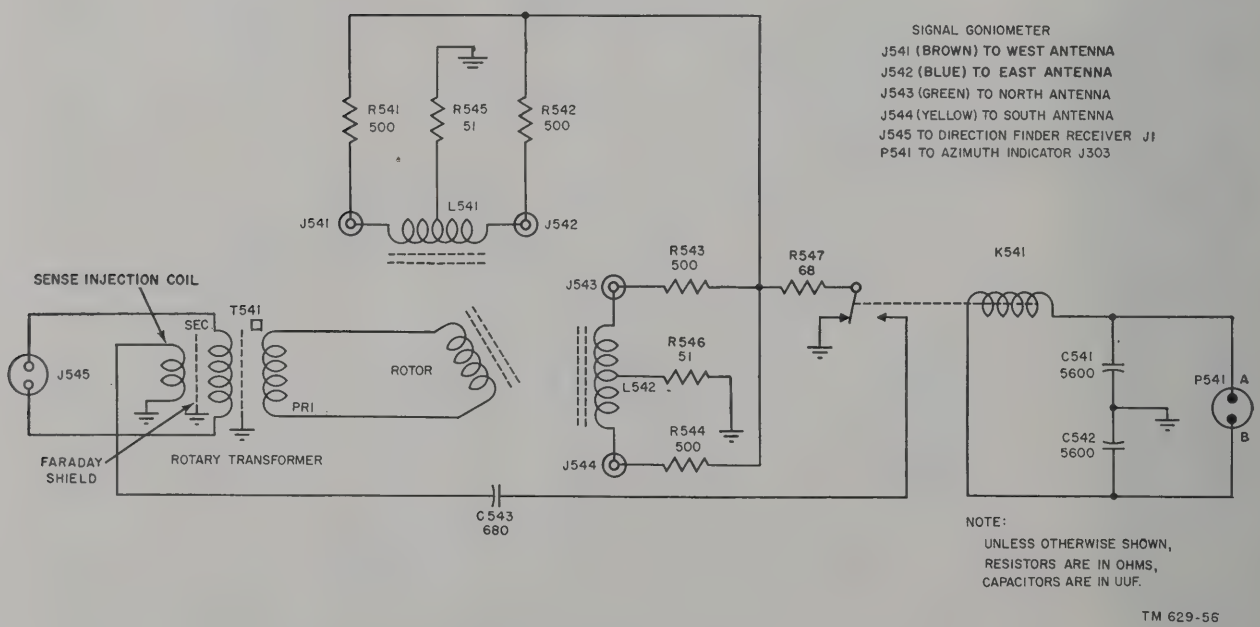
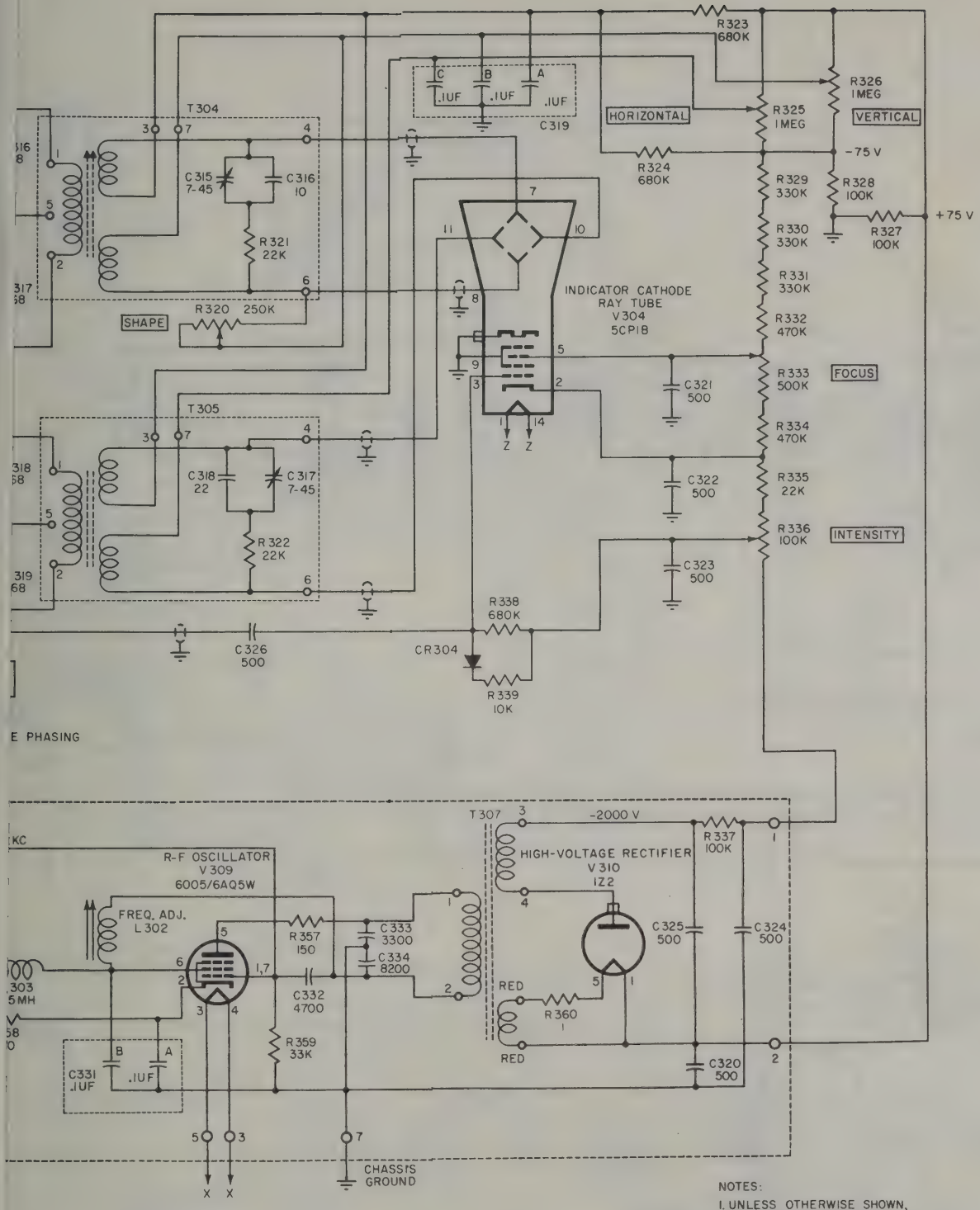


Figure 91. Electrical Goniometer GO–9/TRD–3, schematic diagram.



NOTES:

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF.
2. ROTARY SWITCHES ARE VIEWED FROM RIGHT SIDE SECTIONS DESIGNATED 1 ARE CLOSEST TO RIGHT SIDE.
3. SENSE SWITCH S301 IS IN UNOPERATED POSITION.

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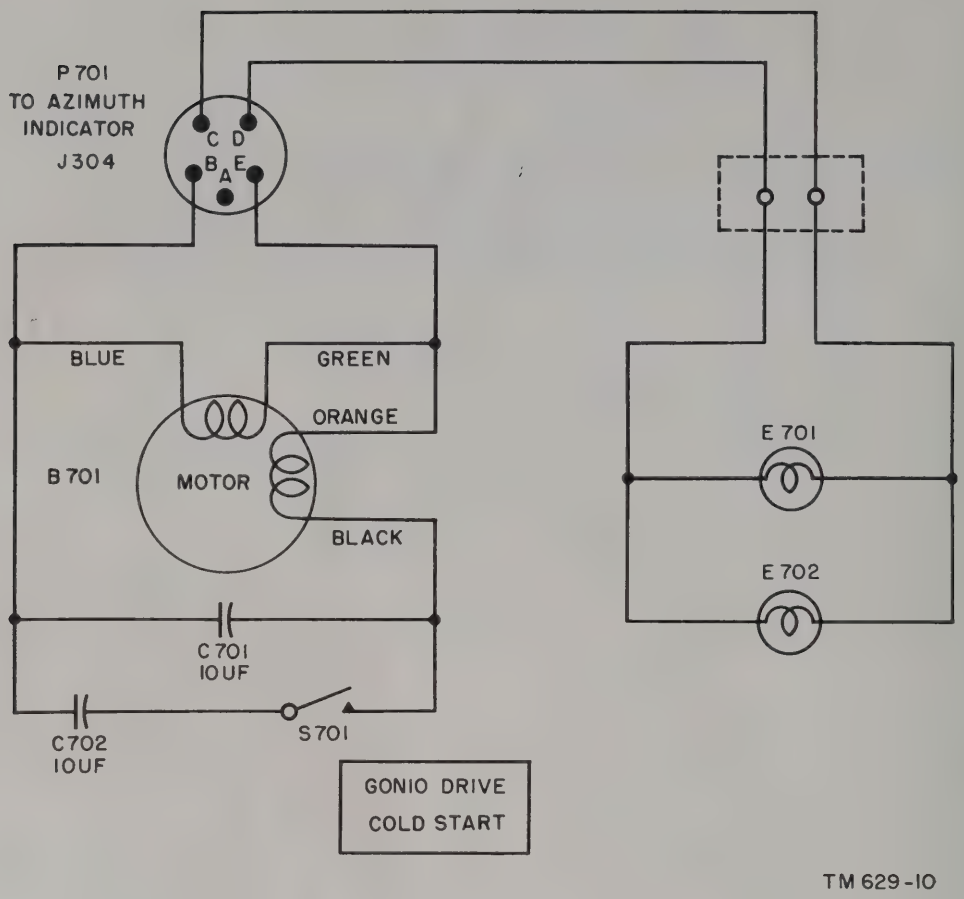


Figure 90. Goniometer drive, schematic diagram.

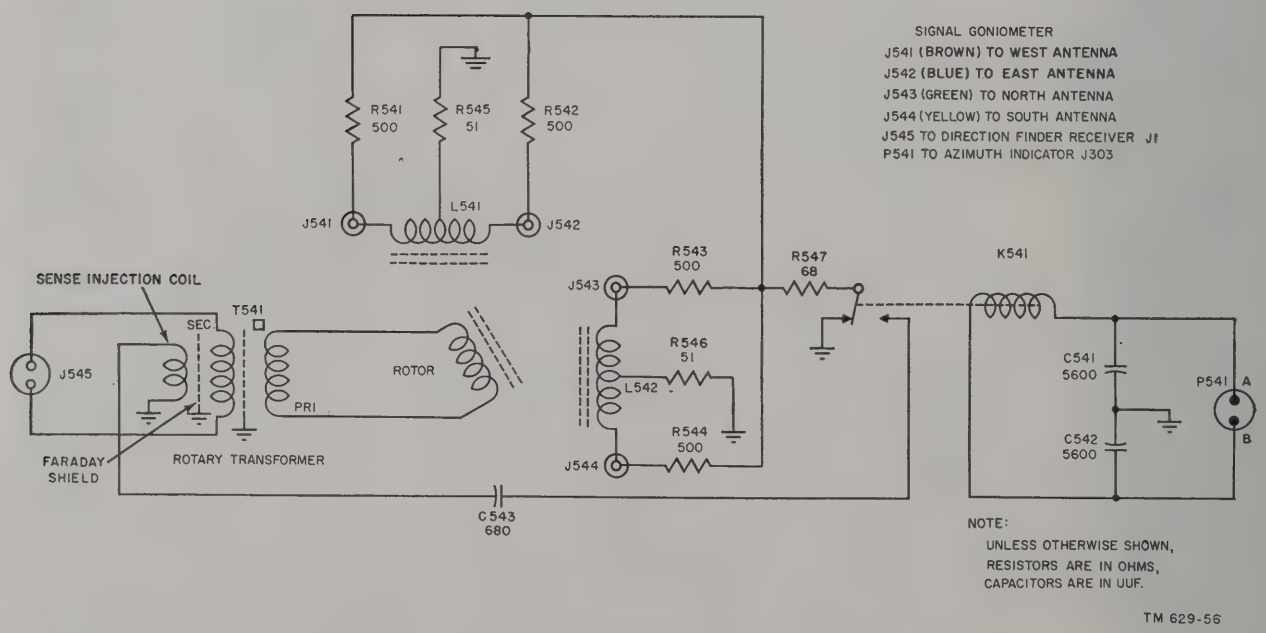
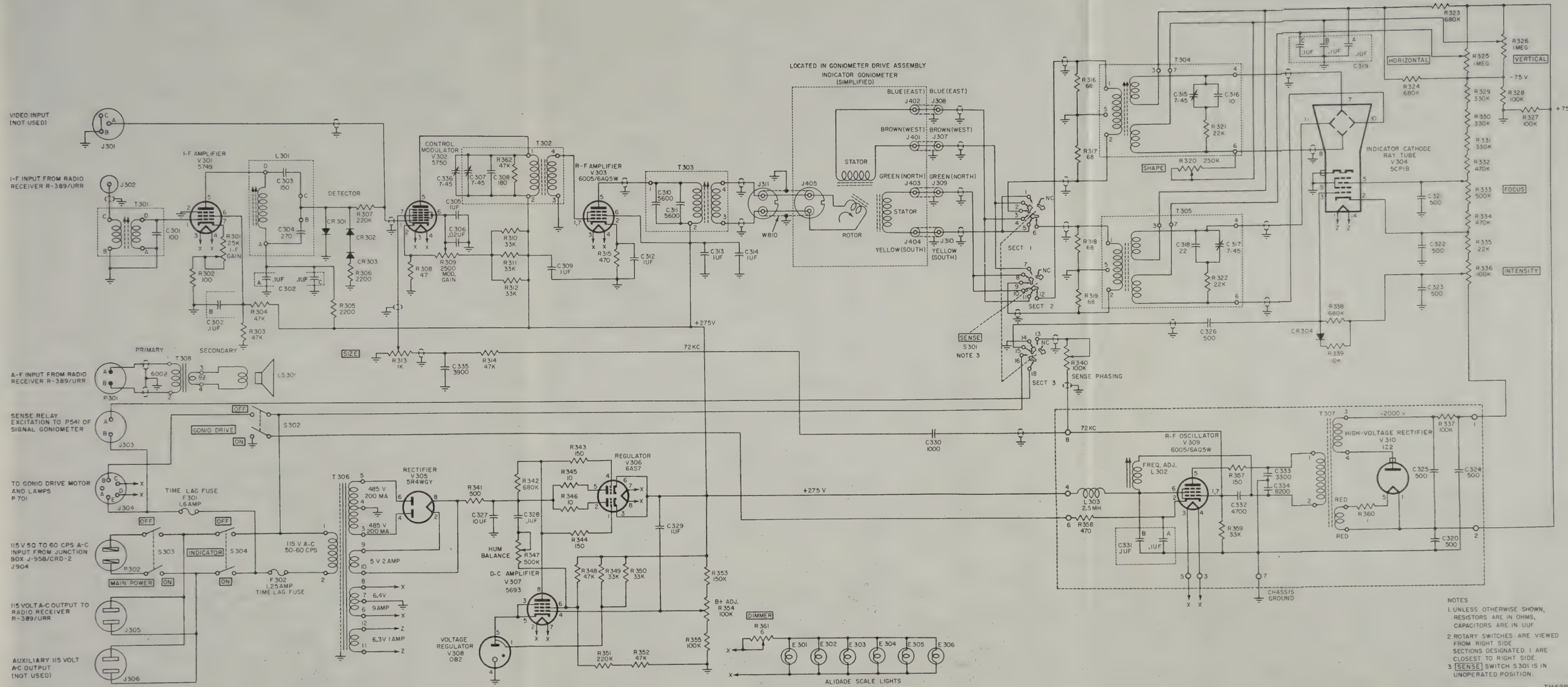


Figure 91. Electrical Goniometer GO–9/TRD–3, schematic diagram.

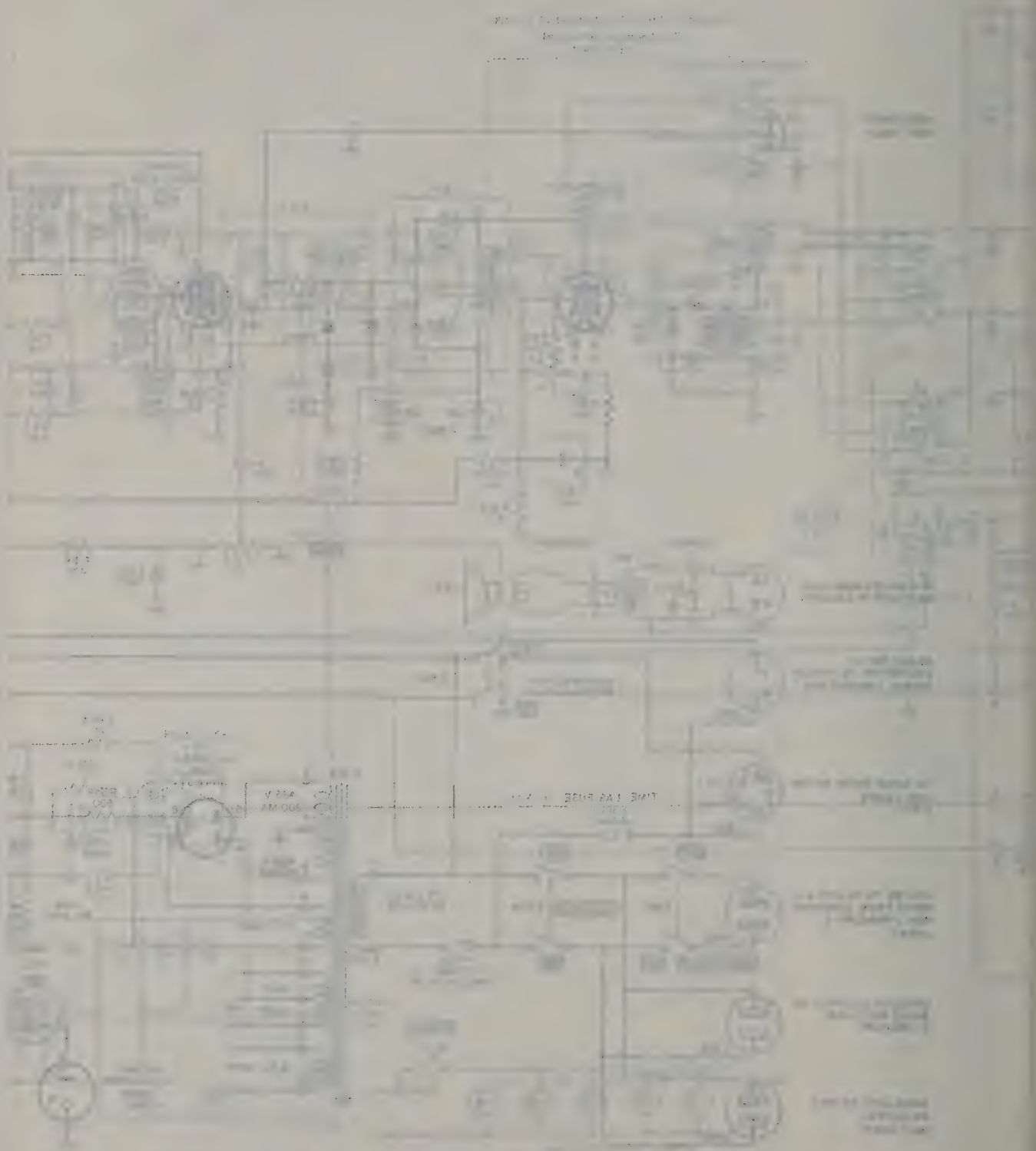


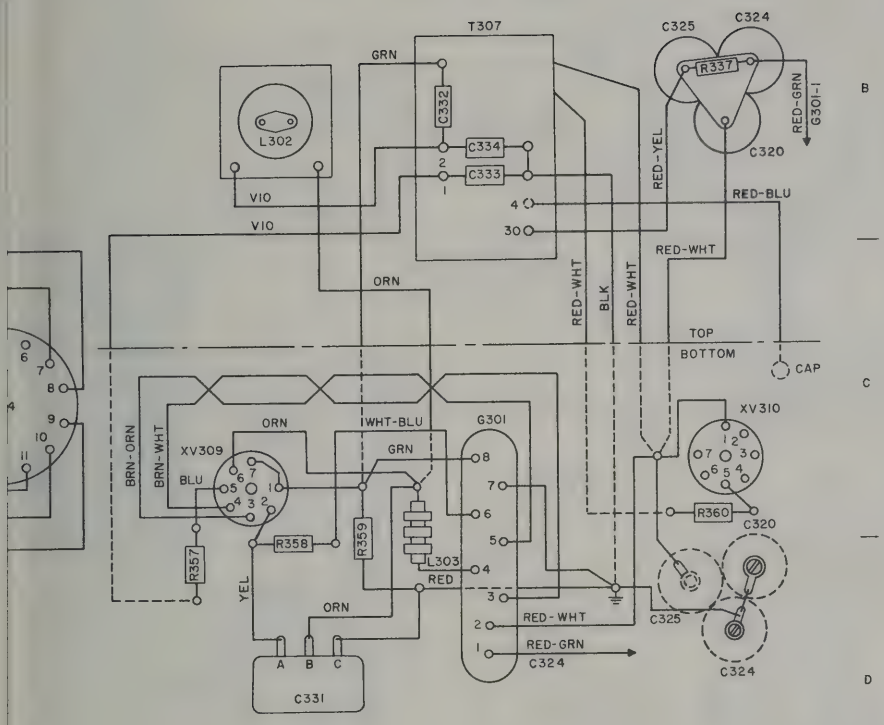
NOTES

1. UNLESS OTHERWISE SHOWN, RESISTORS ARE IN OHMS, CAPACITORS ARE IN UUF
2. ROTARY SWITCHES ARE VIEWED FROM RIGHT SIDE. SECTIONS DESIGNATED 1 ARE CLOSEST TO RIGHT SIDE.
3. [SENSE] SWITCH S301 IS IN UNOPERATED POSITION.

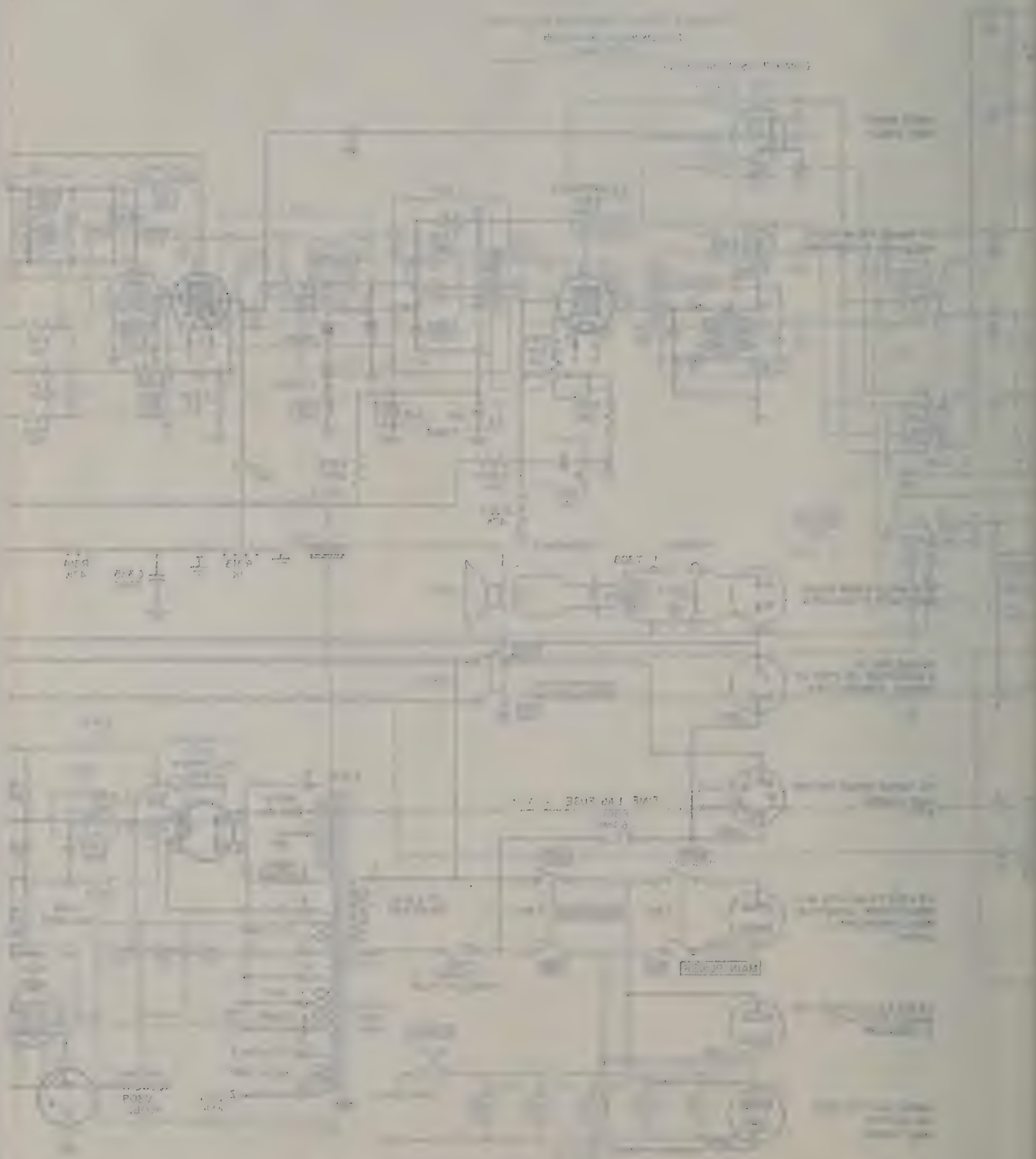
TM629-9

Figure 93. Azimuth Indicator IP-137/GRD, schematic diagram.




T307
GRN
C332
L302
C334
C333
2
1
V10
V10
4
30
C325
C324
R337
C320
RED-GRN
G301-1
RED-YEL
RED-BLU
RED-WHT
ORN
RED-WHT
BLK
RED-WHT
TOP
BOTTOM
CAP
XV310
BRN-ORN
BRN-WHT
XV309
BLU
ORN
WHT-BLU
GRN
G301
R360
C320
R358
R359
R357
L303
RED
YEL
ORN
RED-WHT
RED-GRN
C324
C325
C324
A
B
C
C331

TM629-8



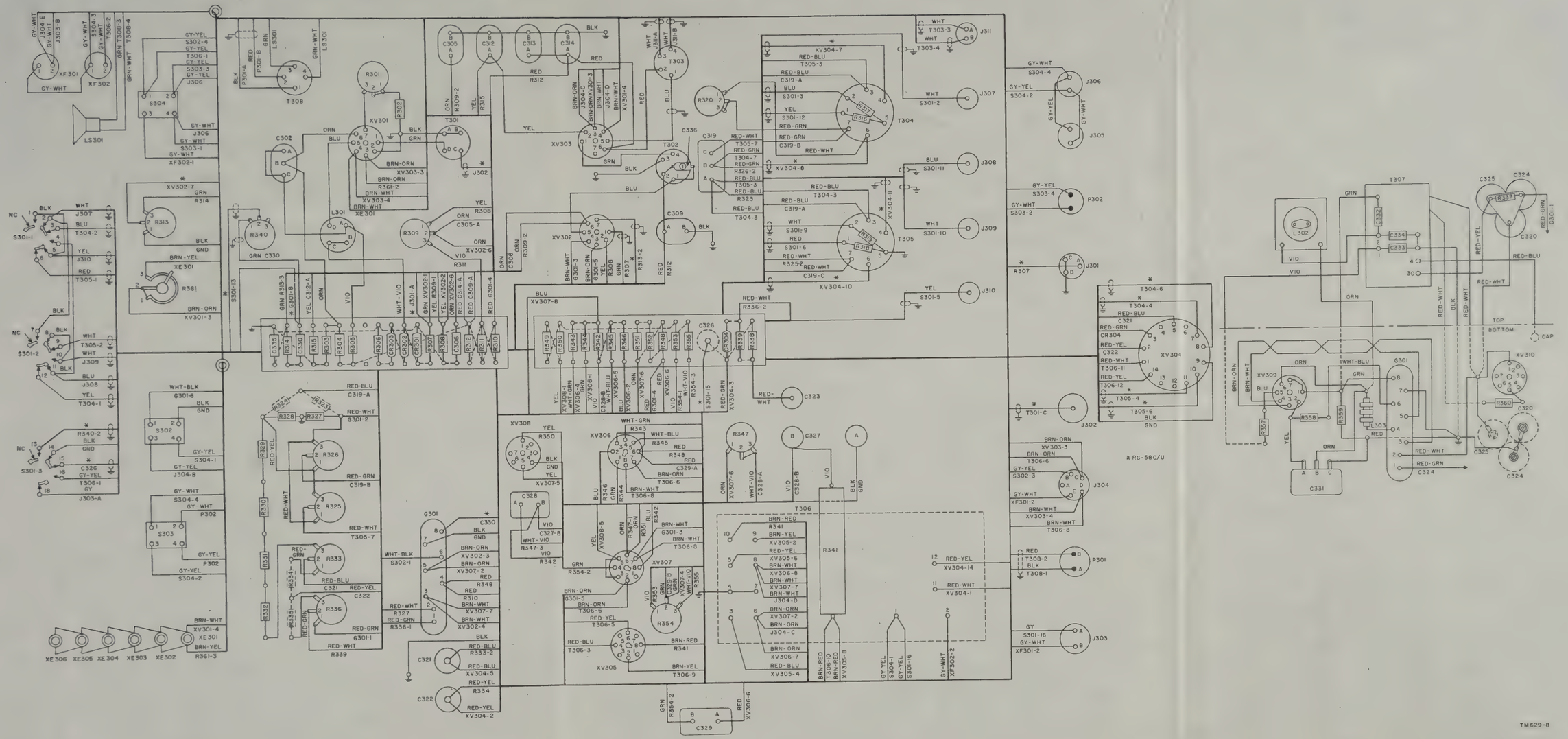
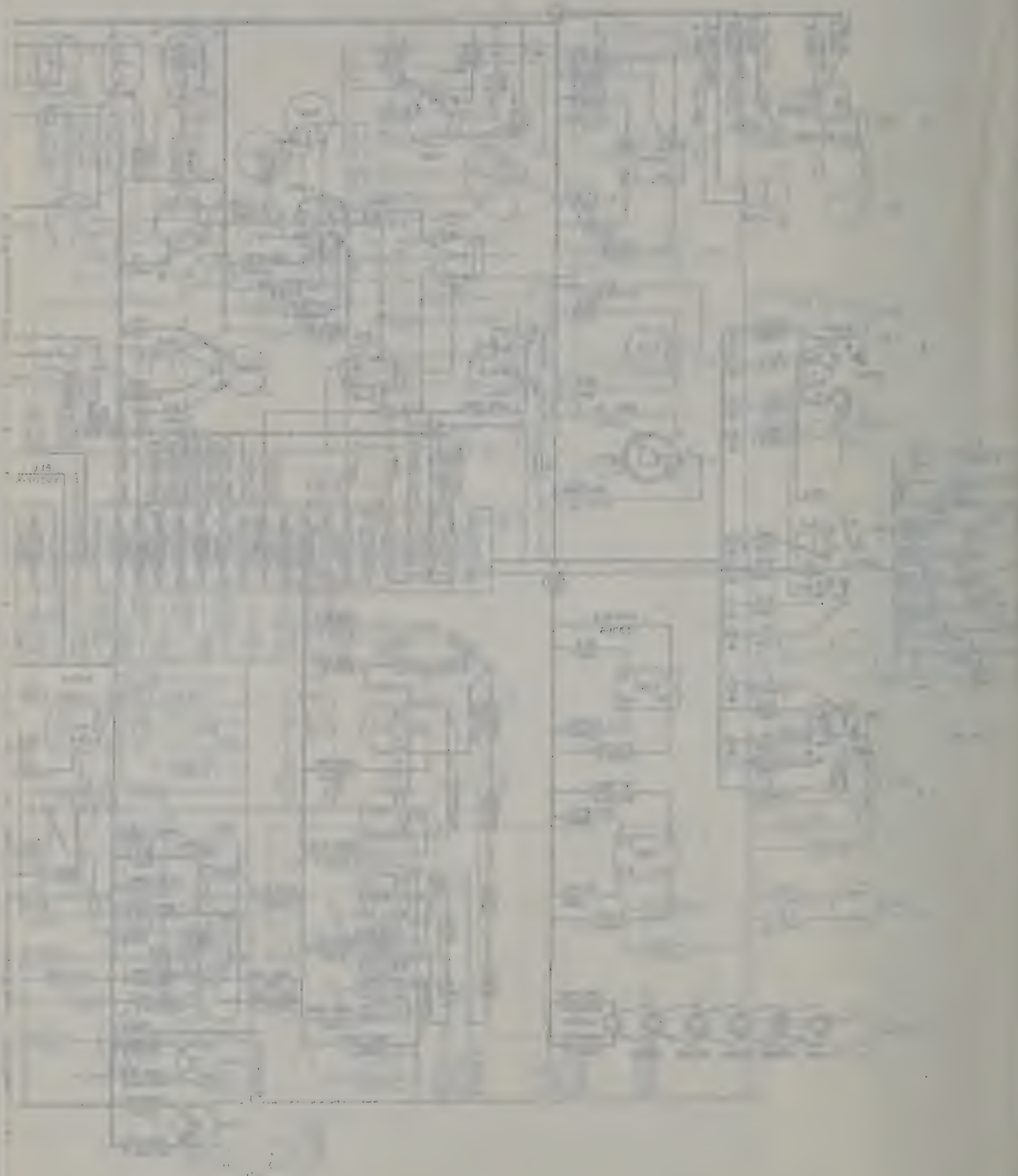
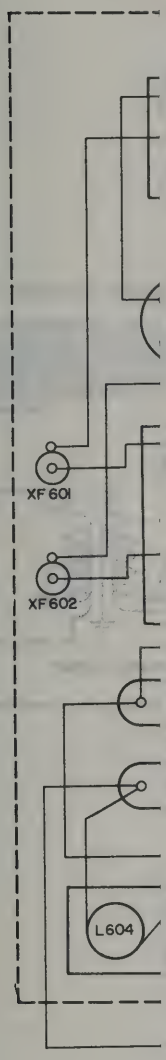
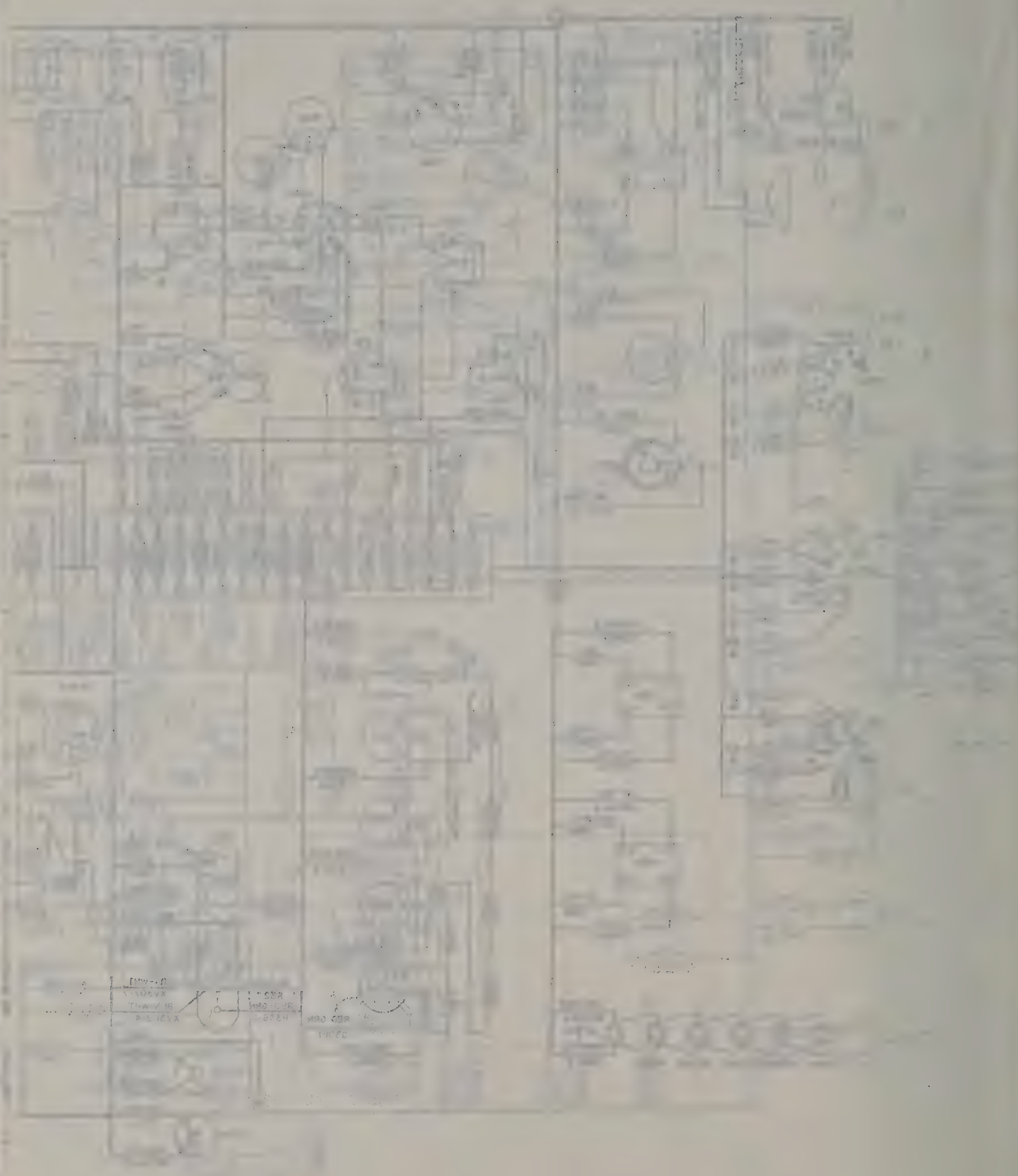


Figure 96. Azimuth Indicator IP–137/GRD, wiring diagram.




XF 601
XF 602
L604



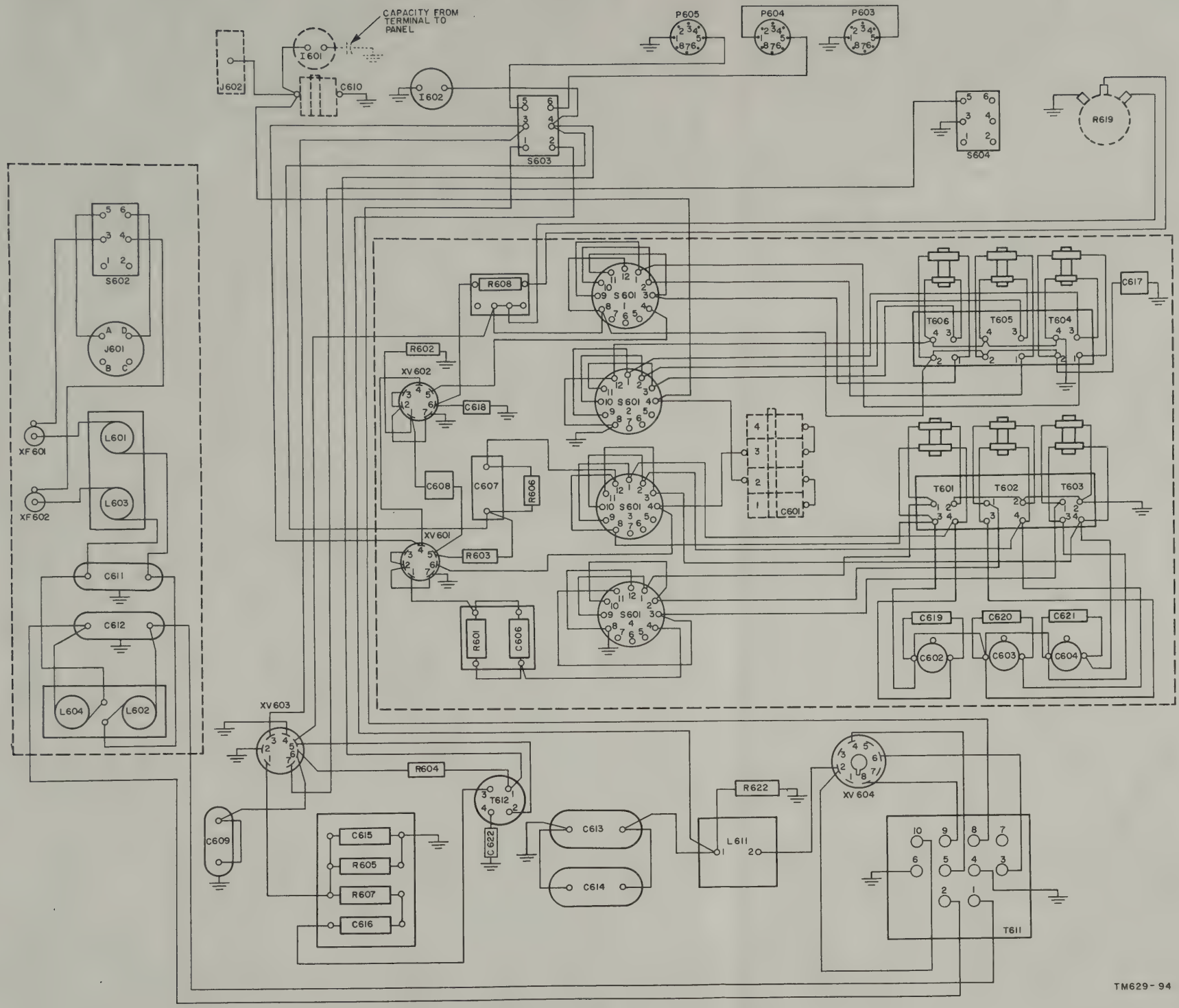
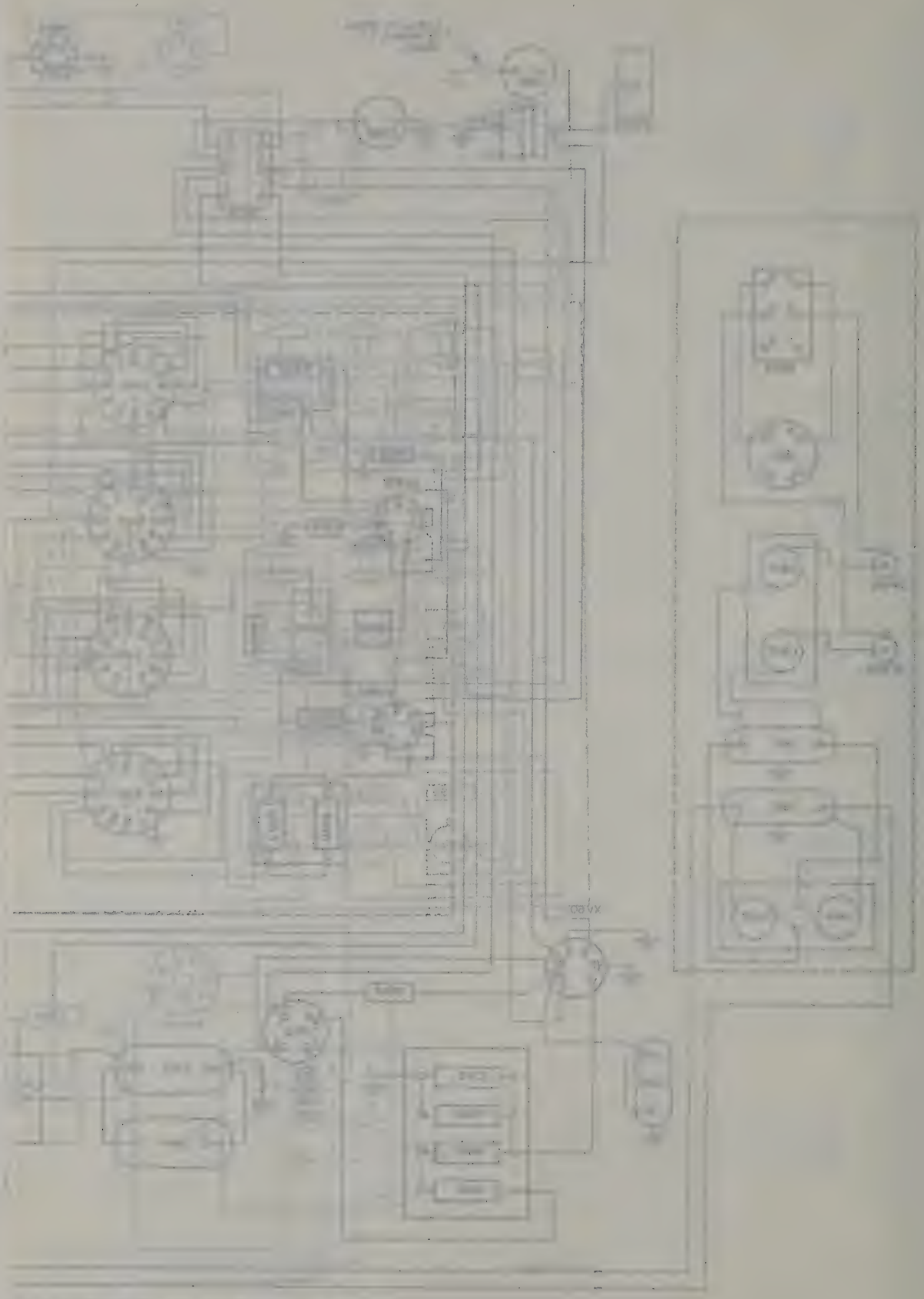


Figure 97. Radio Transmitter T–339/UR, wiring diagram.



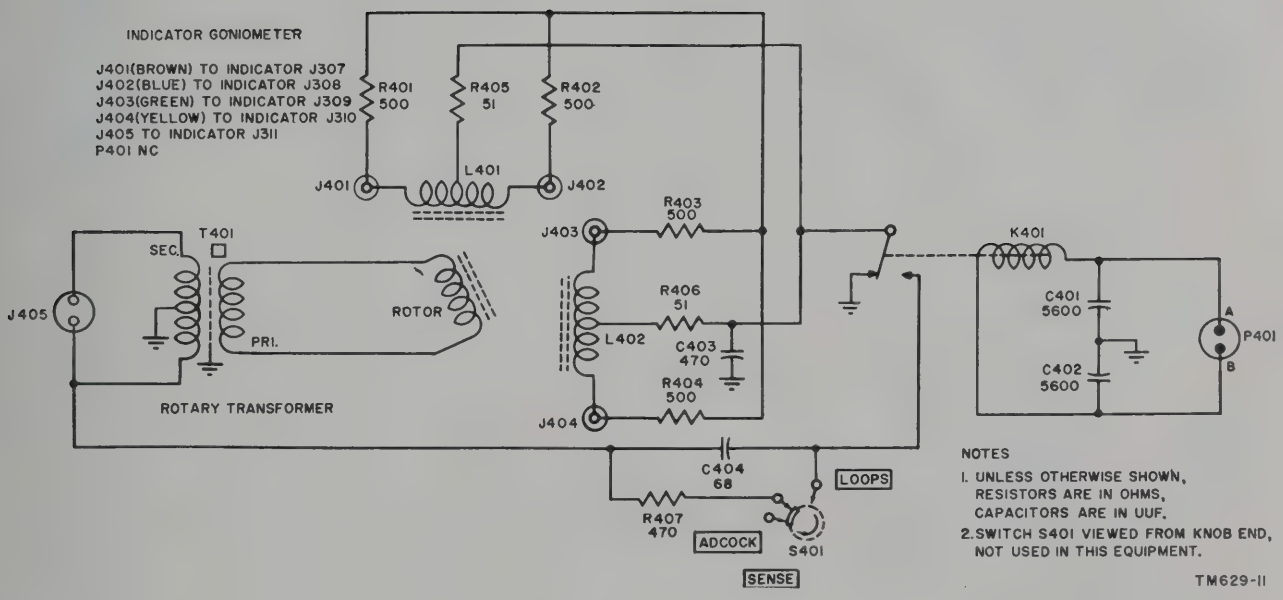
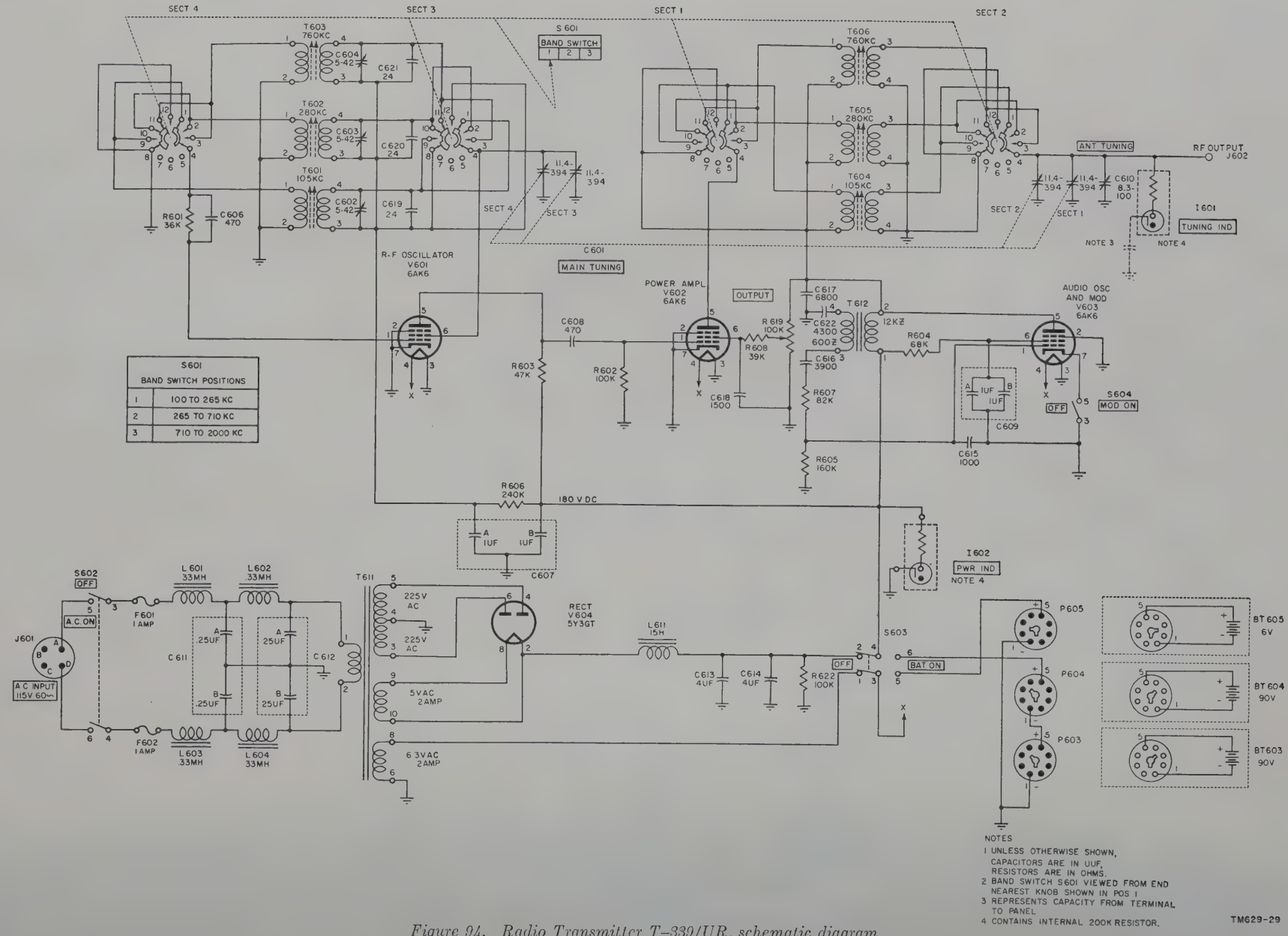


Figure 92. Electrical Goniometer GO–5/GRD, schematic diagram.



NOTES
1 UNLESS OTHERWISE SHOWN, CAPACITORS ARE IN UUF, RESISTORS ARE IN OHMS.
2 BAND SWITCH S601 VIEWED FROM END NEAREST KNOB SHOWN IN POS 1
3 REPRESENTS CAPACITY FROM TERMINAL TO PANEL
4 CONTAINS INTERNAL 200K RESISTOR.

TM629-29

Figure 94. Radio Transmitter T-339/UR, schematic diagram.

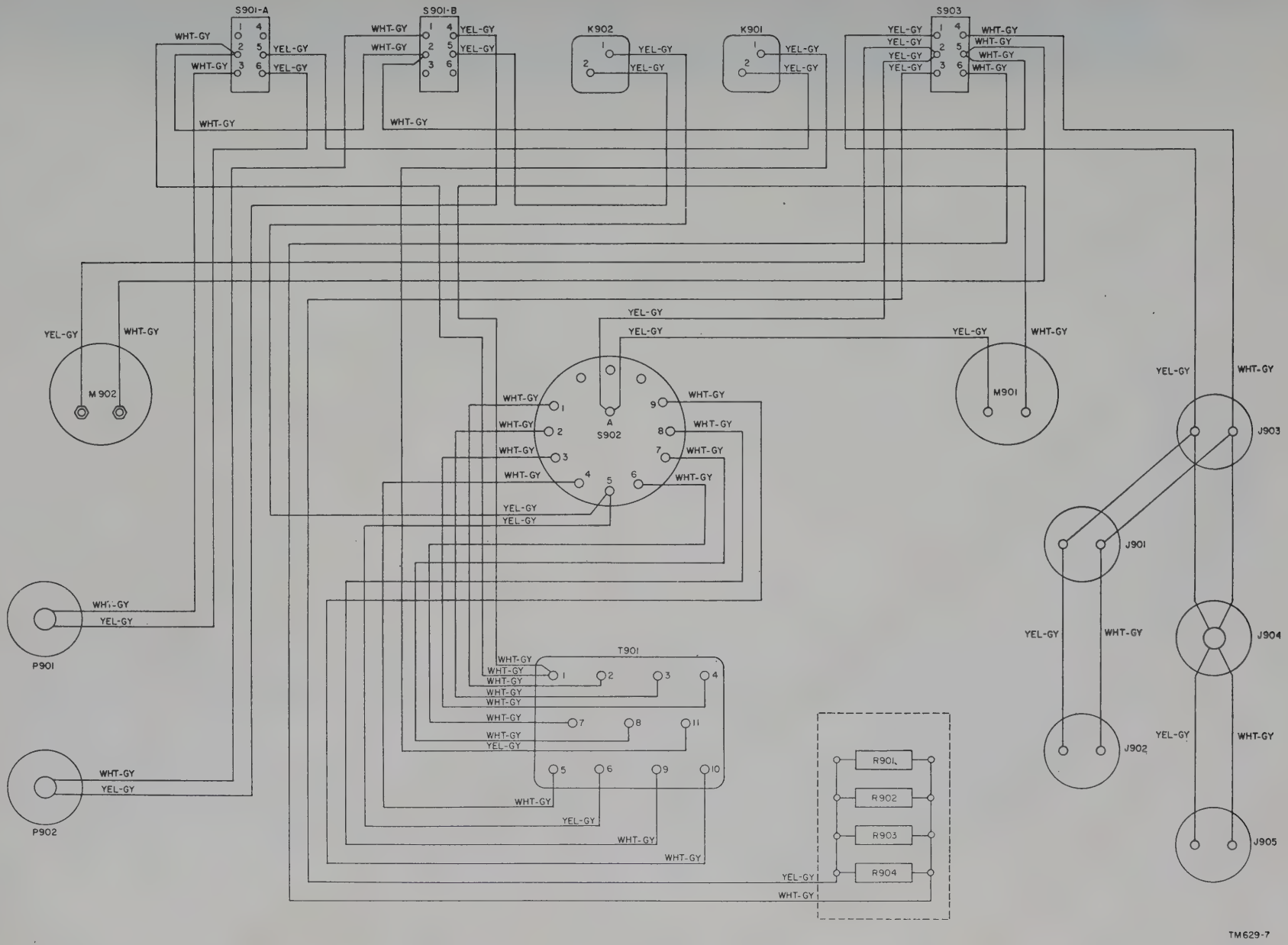


Figure 95. Junction Box J–95B/CRD–2, wiring diagram.

APPENDIX I

TABLE OF COMPONENTS

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Length (in.)	Diameter (in.)	Unit weight (lb)
3	Hand Cable Reeling Machine RL–182/G	15½	13½	14¾			100
4	Radio Frequency Cable Assembly CG–1256/TRD–3 (W801–W804)				1500		½
1	Radio Frequency Cable Assembly CG–257/U (W805)				32		
4	Radio Frequency Cable Assembly CG–1078/U (W806–W809)				43		1
1	Antenna Base Case CY–1657/TRD–3	20	22⅝	43 11/16			110
2	Guy Case CY–1642/TRD–3	19	30	48½			104
1	Indicator Case CY–1853/TRD–3	27½	25½	32¾			107
1	Receiver Case CY–1852/TRD–3	21	25½	37¼			107
1	Transmitter Case CY–1644/TRD–3	17	12½	15			42½
1	Electrical Equipment Rack MT–1600/G	12⅝	18½	20¾			15
1	Electrical Equipment Rack MT–1601/UR	12⅝	14¾	20¼			15
1	Electrical Equipment Rack MT–1599/G	13¼	18½	20¾			18
4	Antenna AS–595/GR consists of—						
1	Mast Section AB–252/GR				114	3	23
1	Mast Section AB–253/GR				114	3	23
1	Mast Section AB–254/GR				114	2¼	18
1	Mast Section AB–255/GR				114	2¼	18
1	Mast Section AB–256/GR				114	2	14
1	Mast Section AB–257/GR				108	2	14
3	Mast Section MS–116A				36	⅜	¼
5	Anchor Rod				35		8
1	Antenna Bag CW–284/GR				47		14
1	Antenna Base AB–398/GR						48
4	Guy MX–1319/GR				750		7
4	Guy MX–1320/GR				570		6
4	Guy MX–1321/GR				420		5
3	Guy plate	¼					1
4	Stake GP–2						1
1	Antenna Counterpoise MX–1317/GR		384	384			31
1	Antenna counterpoise bag						16
1	Antenna Coupler CU–412/TRD–3						3¾
1	Antenna platform	1¼	36	36			32
1	Counterpose ground clamp Counterpose ground conductor						¼
1	Azimuth Indicator IP–137/GRD	10½	17	19			65
1	Goniometer Drive MX–1170/GRD	10½	12¾	19			40
1	Electrical Goniometer GO–5/GRD	5	5½	7¼			4½
1	Electrical Goniometer GO–9/TRD–3	5	5½	7¼			4½
1	Radio Receiver R–389/URR includes— Power Cable Assembly CX–1358/U	12¾	15	19			80
1	Radio Transmitter T–339/UR includes—	17	12½	15			42½
1	Mast Section MS–116A				3	⅜	
1	Mast Section MS–117A				3	⅜	
1	Mast Section MS–118A				3	⅜	
1	Mast Section carrying case						
1	Electrical Power Cable Assembly CX–2966/U (W601)						
	Junction Box J–95B/CRD–2	15½	13½	14¾			64

APPENDIX II

PACKAGING DATA

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)	Quantity	Contents
1 and 2 of 17	16	15	123	17	280	1	Antenna Bag CW–284/GR containing—
						1	Mast Section AB–252/GR
						1	Mast Section AB–253/GR
						1	Mast Section AB–254/GR
						1	Mast Section AB–255/GR
						1	Mast Section AB–256/GR
						1	Mast Section AB–257/GR
						1	Gin Pole Derrick MX–1318/GR (2 per system—1 in use, 1 running spare)
						3	Antenna mast guy plate
						1	Counterpoise bag containing—
						1	Antenna Counterpoise MX–1317/GR
						10	Ground rod (8 in use, 2 running spares)
3, 4 and 5 of 17	16	15	123	17	267	1	Antenna Bag CW–284/GR containing—
						1	Mast Section AB–252/GR
						1	Mast Section AB–253/GR
						1	Mast Section AB–254/GR
						1	Mast Section AB–255/GR
						1	Mast Section AB–256/GR
						1	Mast Section AB–257/GR
						3	Antenna mast guy plate
						1	Counterpoise bag containing—
						1	Antenna Counterpoise MX–1317/GR
						10	Ground rod (8 in use, 2 running spares)
6 of 17	23	41	27	14.6	263	1	Receiver Case CY–1852/TRD–3 containing—
						1	Radio Receiver R–389/URR
						1	Cable Assembly, Power Electrical CX–3332/U (3 ft 10 in.)
						1	Electrical Power Cable Assembly CX–3331/U (3 ft 2 in.)
						1	Electrical Power Cable Assembly CX–3330/U (2 ft 10 in.)
						1	Radio Frequency Cable Assembly CG–1079/U (4 ft 1 in.)
						1	Radio Frequency Cable Assembly CG–1079/U (3 ft 8 in.)
						1	Radio Frequency Cable Assembly CG–1257/U (2 ft 8 in.)
						3	Radio Frequency Cable Assembly CG–1078/U (3 ft 7 in.)
						1	Radio Frequency Cable Assembly CG–1078/U (3 ft 7 in.)
						1	Spintite wrench 7/16
						1	Spintite wrench 9/16
							Electrical running spares for AN/TRD–3 consisting of—
						1	Set for azimuth indicator consisting of—
						1	5CP1B tube
						1	5R4WGY tube
						1	1Z2 tube
						1	6AS7 tube
						1	5693 tube

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)	Quantity	Contents
							Electrical running spares for AN/TRD–3—Continued
							Set for azimuth indicator—Continued
						1	OB2 tube
						1	5479 tube
						1	6AQ5W tube
						1	5750 tube
						6	1.6 amp fuse
						1	1.25 amp fuse
						3	#47 dial lamp
						4	IN69 crystal diode
						1	Alinement tool
						1	Anti-static wax, 1 oz. bottle
						1	Set for Goniometer MX–1170/GRD consisting of—
						1	#47 dial lamp
						1	Sealed box of spare parts supplied with Radio Receiver R–389/URR.
						1	Set for Radio Transmitter T–339/UR consisting of—
						2	Tube 6AK6
						1	Tube 5Y3WGT
						1	Dial Lamp NE51 46A–58571–4
						6	Fuse, 1-amp 46B–59486–14
						2	Technical Manual TM 11–855
7 of 17	21	52	34	21	403	1	Accessories Case CY–1647/TRD–3 containing—
						1	Bracket (for Telephone EE–8)
						1	Plumb bob, 12 oz. brass
						1	Compass
						2	Pipe strap wrench (2 spare straps)
						1	Compass mounting adapter
						1	Tripod
						1	Steel tape measure (100 ft)
						1	Ball and socket
						1	Paint, blue
						1	Paint, brown
						1	Paint, green
						1	Paint, yellow
						1	6# Sledge hammer
						1	Spintite wrench
						1	Terminal box
						1	Block and tackle
						1	Rod level
						2	Electrical Power Cable Assembly CX–2383/U (12 ft 0 in.)
						1	Electrical Power Cable Assembly CX–2381/U (10 ft 0 in.)
						1	Radio Frequency Cable Assembly CG–1079/U (3 ft 8 in.) (Running spare).
						1	Radio Frequency Cable Assembly CG–1079/U (4 ft 1 in.) (Running spare).
						1	Radio Frequency Cable Assembly CG–1257/U (2 ft 8 in.) (Running spare).
						1	Radio Frequency Cable Assembly CG–1078/U (3 ft 7 in.) (Running spare).
						1	Electrical Power Cable Assembly CX–2966/U (8 ft 3 in.)

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)	Quantity	Contents
							Accessories Case CY–1647/TRD–3—Continued
						1	Junction Box J–95B/CRD–2
						1	Telephone EE–8
						1	Headset CW–49507–A with extension Cord CD307A
						20	Mast Section MS–116A
						1	Screwdriver TL–499/U
						1	Bag containing—
						3	Mast Section MS–116A
						1	Mast Section MS–117A
						1	Mast Section MS–118A
8 of 17	42	48	20	23	425	1	Accessories Case CY–1646/TRD–3 containing—
						1	Table, mounting
						2	Chair, folding type
						4	Platform
9 of 17	29	27	27	12	202	1	Hand Cable Reeling Machine RL–182/G containing—
						2	Radio Frequency Cable Assembly CG–1256/TRD–3.
						2	Radio Frequency Cable Assembly CG–1256/TRD–3.
10 of 17	44	23	23	13	445	1	Accessories Case CY–1640/TRD–3 containing—
						25	Stake GP–2 (16 in use, 9 running spares)
						30	Anchor rod (24 in use, 6 running spares)
11 of 17	29	36	27	16	317	1	Indicator Case CY–1853/TRD–3 containing—
						1	Azimuth Indicator IP–137/GRD
						1	Electrical Goniometer GO–5/GRD
						1	Goniometer Drive MX–1170/GRD
						1	Electrical Goniometer GO–9/TRD–3
12 of 17	20	33	23	8.7	171	1	Transmitter Case CY–1644/TRD–3 containing—
						1	Radio Transmitter T–339/UR
						5	Antenna Coupler CU–412/TRD–3
13 of 17	15	46	32	12.6	348	1	Guy Case CY–1642/TRD–3 containing—
						14	Guy MX–1319/GR (16 in use, 4 running spares).
							(See guys in No. 14 box)
						6	Guy MX–1320/GR (16 in use, 4 running spares).
							(See guys in No. 14 box)
						10	Guy MX–1321/GR (16 in use, 4 running spares).
							(See guys in No. 14 box)
14 of 17	15	46	32	12.6	352	1	Guy Case CY–1642/TRD–3 containing—
						6	Guy MX–1319/GR (16 in use, 4 running spares).
							(See guys in No. 13 box)
						14	Guy MX–1320/GR (16 in use, 4 running spares).
							(See guys in No. 13 box)
						10	Guy MX–1321/GR (16 in use, 4 running spares).
							(See guys in No. 13 box)

PACKAGING DATA—Continued

Crate No.	Height (in.)	Width (in.)	Depth (in.)	Volume (cu ft)	Weight (lb)	Quantity	Contents
15 of 17	29	27	27	12	271	1	Hand Cable Reeling Machine RL–182/G containing—
						1	Electrical Power Cable Assembly CX–2965/U (300 ft).
16 of 17	29	27	27	12	213	1	Hand Cable Reeling Machine RL–182/G containing—
						1	Radio Frequency Cable Assembly CG–1256/TRD–3 (Green Color Code)
						1	Radio Frequency Cable Assembly CG–1256/TRD–3 (Yellow Color Code)
						1	Radio Frequency Cable Assembly CG–1256/TRD–3 (Blue Color Code)
						1	Radio Frequency Cable Assembly CG–1256/TRD–3 (Brown Color Code)
17 of 17	24	48	22	14.5	420	1	Antenna Base Case CY–1657/TRD–3 containing—
						5	Antenna Base AB–398/GR (4 in use, 1 running spare).
						10	Electrical lead (4 in use, 6 running spares).

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[AG 413.44 (2 Jul 57)]

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NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see AR 320–50.

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